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Final Technical Report
October 1994

CATHODE LIFE TEST FACILITY

ARC Professional Services Group

Ronald J. Jardieu

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Rome Laboratory
Air Force Materiel Command
Griffiss Air Force Base, New York

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13. ABSTRACT (Maximum 200 words)

The Cathode Life Test Facility (CLTF) has been in operation for ten years and has tested ten different cathode types for a total of approximately 2.0 million hours of life test data. As part of the Defense Management Review (DMR) process, Rome Laboratory (RL) has eliminated internal research efforts pertaining to cathode life testing. Based on this directive, the CLTF was moved to the Naval Surface Warfare Center (NSWC) at Crane, Indiana. This report summarizes the process of moving the CLTF from RL to the NSWC. The point of contact at NSWC is David Windes, (812) 854-4735.

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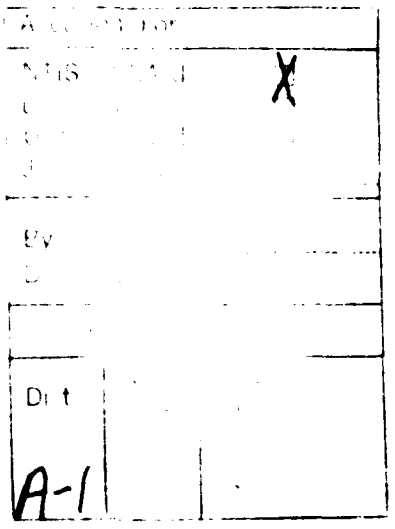

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1.0 INTRODUCTION

This report summarizes the work carried out under contract F30602-89-0028 Task 034, during the period of August 2, 1991 thru September 2, 1992. The objective of this work was the operation of the Rome Laboratory(RL) Cathode Life Test Facility. This included the day to day operations, the periodic calibrations, roll-offs and Miram curves and the performance of prompt unscheduled maintenance and repair when required. In addition, an amendment to the original statement of work required the development of a spare parts inventory, establishment of a power supply work area, and the creation of a data base which would allow for the development of long-term cathode performance plots.

1.1 Facility Description

The Cathode Life Test Facility is located in building 112, of RL, at Griffiss Air Force Base and is comprised of the main test facility, located in cell 8B and of the repair area and working stock store room in cell 8A. The facility has been in operation for approximately 11 years. During this time the various cathodes on life test have accumulated approximately 2,450,000 hours of life test time under simulated life test conditions. The accumulated total life hours by cathode type is given in Table 1. Figure 1-1 presents these hours in a bar graph. The facility is presently equipped with 38 power supplies manufactured by Cober Electronics and 2 power supplies manufactured by RL. Each cathode has its own power supply and shares a vac-ion pump power supply with up to 9 other cathodes. Figure 1-2 shows the floor plan for the life test facility and indicates which power supply is connected to each cathode. Figure 1-3 gives the life test facility dimensions as well as the detailed power supply dimensions. It also details the lighting system, the prime power supplied and the air conditioner specifications. The electrical power supply specifications are given in Table 2.

2.0 SCHEDULED FACILITY OPERATIONS

2.1 Daily

Each work day morning all power supply readings were taken and recorded in the Cathode Life Test Daily Meter Logs. Any discrepancies were noted and corrected. All power supply drift was corrected by resetting each power supply to the prescribed voltages as indicated by a voltage settings reference card affixed to the front of each power supply. All vac-ion indications were checked for any change in readings. The air-conditioner and circulation fans were checked. The Lab Daily log was annotated. Any major problems were reported to the RL project manager.

2.2 Monthly

Each month new daily meter logs were started. A monthly report was produced detailing the month's activities including any cathode vehicle changes, primary power failures, and any power

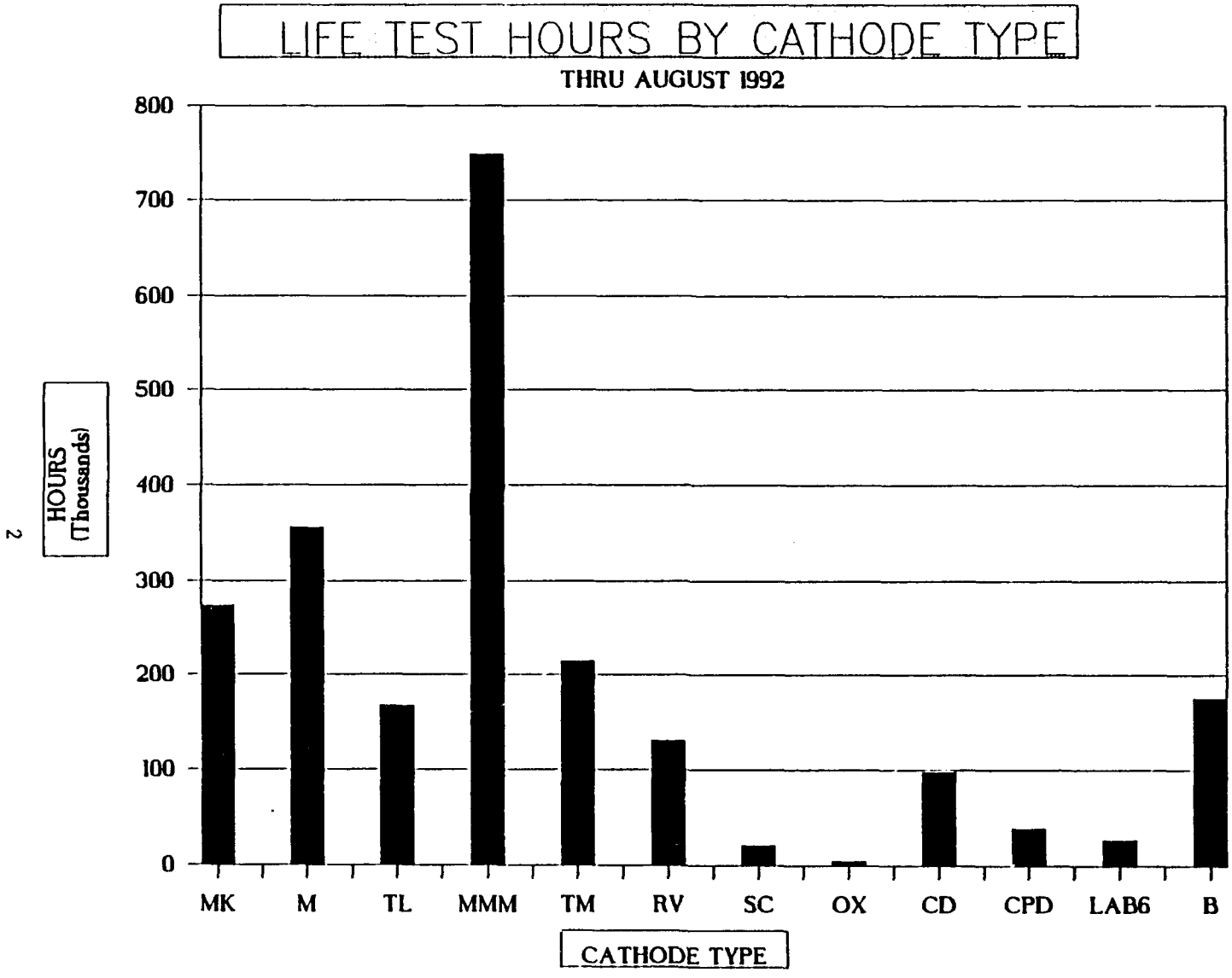

Figure 1-1. Life Test Hours by Cathode Type

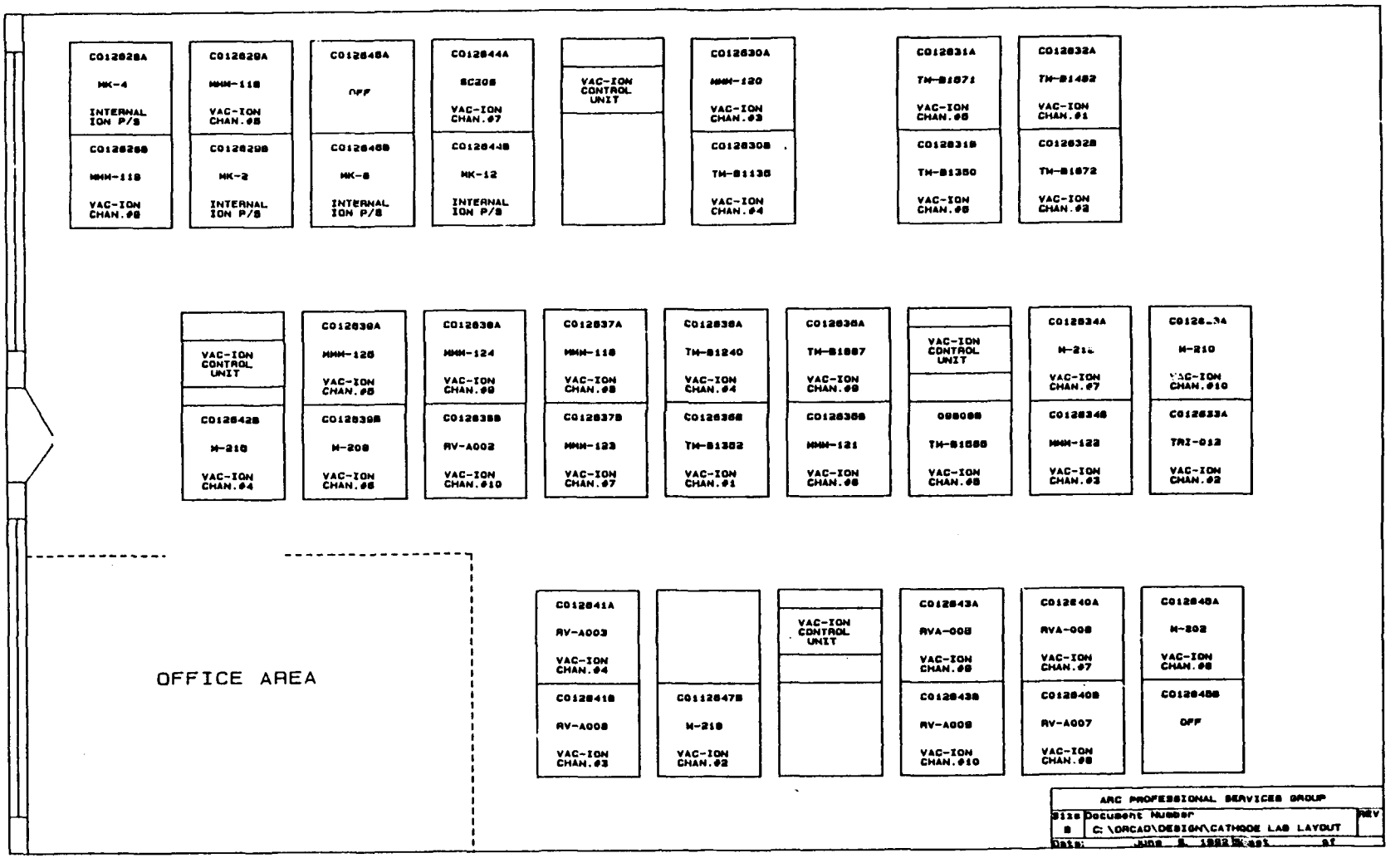

Figure 1-2. Cathode Lab Layout

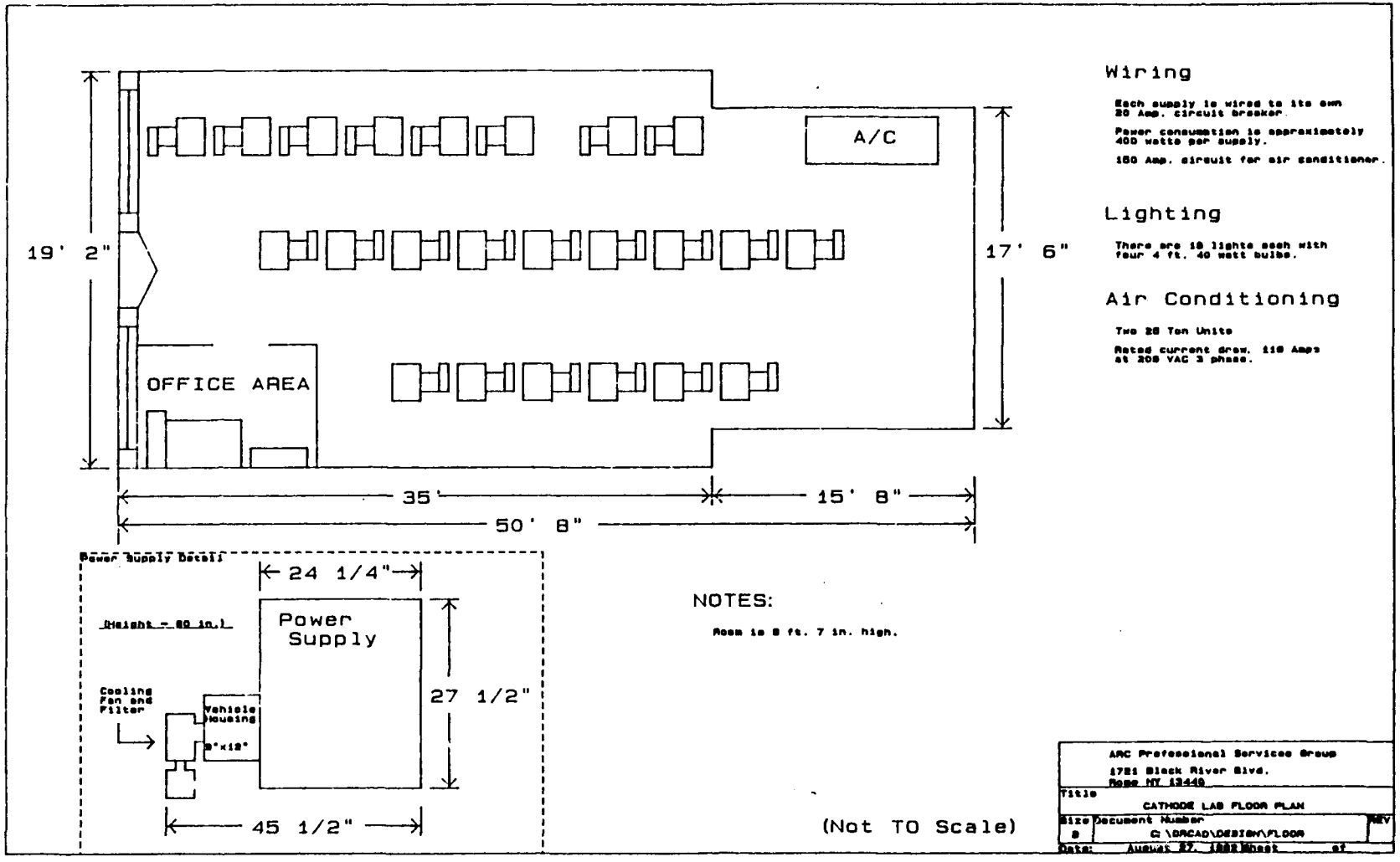

Figure 1-3. Cathode Lab Floor Plan

Life Hours as of the End of August

Cathode Type	*Total Life Hours*
MK	273,855.5
M	356,240.3
TL	167,098.4
MMM	749,041.6
TM	214,595.7
RV	130,252.7
SC	21,041.9
OX	5,139.0
CD	98,176.0
CPD	39,135.0
LAB6	26,835.0
B	175,347.0

Table 1. Cathode Life Hours

POWER SUPPLY ELECTRICAL SPECIFICATIONS

1) Input Voltages: 115VAC, 1 Phase, 60Hz, 3 Wire.

Variations in input voltages are accomodated by the regulator.

2) Cathode Power Supply:

A- Output Voltage: Manually adjustable 0 to -6KV D.C.

B- Output Current: 20 mA (min.) .

C- Regulation: Better than 1%.

D- Ripple: Less than 4 volts peak-to-peak.

3) Collector Power Supply:

A- Output Voltage: Fixed ratio (0.3 +/- 10%) of 6KV with respect to ground. Manually adjustable 0 to +2KV D.C. with respect to cathode.

B- Output Current: 240 mA (min.)

C- Regulation: Better than 5%.

D- Ripple: Better than 5%.

4) Filament Power Supply

A- Output Voltage: Variable 0 to 10VAC.

B- Output Current: 4 amps RMS (min.)

C- Regulation: Better than 1%.

Table 2. Power Supply Specs

MONTHLY CATHODE FACILITY CONDITION REPORT

AUGUST 1992

	TYPE	S/N	MFR	P/S CO...	LOAD I DENSITY	FILAMENT E	FILAMENT I	FILAMENT WATTS	PREVIOUS LIFE HRS.	ETM THIS MO.	ETM LAST MO.	LIFE HRS. THIS MO.	TOTAL LIFE HOURS	BODY CURRENT	COMMENTS
1	MK	2	SIEMENS	12629B	2A/SQ CM	6.26	1.26	7.89	45,546.6	70,436.5	69,674.3	762.2	46,308.8	0.6ma	
2	MK	4	SIEMENS	12628A	4A/SQ CM	6.22	1.31	8.15	48,263.4	61,309.7	60,547.5	762.2	49,025.6	0.5ma	
3	MK	8	SIEMENS	12646B	4A/SQ CM	6.32	1.35	8.53	47,183.9	62,956.2	62,194.0	762.2	47,946.1	0.5ma	
4	MK	12	SIEMENS	12644B	2A/SQ CM	5.33	1.22	6.50	45,677.9	25,826.9	25,064.6	762.3	46,440.2	0.0ma	
5	M	202	SEMICON	12645A	2A/SQ CM	5.50	2.25	12.38	51,695.0	48,880.4	48,119.5	760.9	52,455.9	1.0ma	
6	M	209	SEMICON	12639B	2A/SQ CM	4.88	2.14	10.44	61,231.7	70,107.5	69,346.6	760.9	61,992.6	1.0ma	
7	M	210	SEMICON	12633A	2A/SQ CM	4.70	2.06	9.68	17,049.7	54,944.0	54,183.4	760.6	17,810.3	1.5ma	
8	M	212	HUGHES	12634A	4A/SQ CM	5.80	2.28	13.22	49,861.9	10,103.5	9,343.0	760.5	50,622.4	2.4ma	
9	M	215	SEMICON	12642B	2A/SQ CM	4.54	2.04	9.26	17,330.2	49,593.3	48,834.3	759.0	18,089.2	1.0ma	
10	M	218	SEMICON	12647B	2A/SQ CM	4.72	2.05	9.68	17,164.4	19,742.7	18,981.8	760.9	17,925.3	1.0ma	
11	TL	012	VARIAN	12633B	4A/SQ CM	5.37	2.23	11.98	54,820.9	46,573.3	45,812.7	760.6	55,581.5	2.6ma	
12	MMM	116	VARIAN	12637A	1A/SQ CM	5.20	2.11	10.97	59,237.6	67,116.4	66,357.7	760.7	59,998.3	0.6ma	(RESTARTED) life test - 5/91
13	MMM	118	VARIAN	12629A	1A/SQ CM	5.25	2.11	11.08	52,769.9	15,882.4	15,120.2	762.2	53,532.1	0.5ma	(RESTARTED) life test - 5/91
14	MMM	119	VARIAN	12628B	1A/SQ CM	5.00	2.16	10.80	56,252.6	46,844.2	46,082.0	762.2	57,014.8	0.3ma	(RESTARTED) life test - 5/91
15	MMM	120	VARIAN	12630A	2A/SQ CM	5.50	2.17	11.94	73,142.1	26,124.5	25,362.2	762.3	73,904.4	7.1ma	
16	MMM	121	VARIAN	12635B	2A/SQ CM	5.36	2.23	11.95	72,318.4	69,358.8	68,607.8	751.0	73,069.4	7.6ma	
17	MMM	122	VARIAN	12634B	2A/SQ CM	5.87	2.34	13.74	72,214.7	51,692.9	50,932.3	760.6	72,975.3	1.6ma	
18	MMM	123	VARIAN	12637B	2A/SQ CM	5.97	2.43	14.51	70,604.5	71,801.6	71,040.9	760.7	71,365.2	0.7ma	
19	MMM	124	VARIAN	12638A	2A/SQ CM	5.55	2.40	13.32	73,038.5	62,749.6	61,988.9	760.7	73,799.2	0.8ma	
20	MMM	125	VARIAN	12639A	2A/SQ CM	5.95	2.34	13.92	74,942.1	75,986.0	75,225.3	760.7	75,702.8	1.0ma	
21	TM	B1135	VARIAN	12630B	4A/SQ CM	5.35	2.03	10.86	24,570.5	57,603.1	56,840.7	762.4	25,332.9	2.6ma	
22	TM	B1240	VARIAN	12636A	4A/SQ CM	5.40	2.23	12.04	21,026.7	67,870.2	67,122.5	747.7	21,774.4	1.5ma	
23	TM	B1350	VARIAN	12631B	4A/SQ CM	5.37	2.10	11.28	23,951.7	67,709.9	66,949.3	760.6	24,712.3	3.1ma	
24	TM	B1352	VARIAN	12636B	4A/SQ CM	5.43	2.29	12.43	23,243.2	68,912.5	68,164.8	747.7	23,990.9	1.3ma	
25	TM	B1462	VARIAN	12632A	4A/SQ CM	5.30	2.06	10.92	24,655.7	66,673.7	65,913.1	760.6	25,416.3	1.0ma	

Table 3. Monthly Cathode Facility Report

	TYPE	S/N	MFR	P/S CO...	LOAD I DENSITY	FILAMENT E	FILAMENT I	FILAMENT WATTS	TOTAL IFE HOUR	ETM THIS MO.	ETM LAST MO.	LIFE HRS. THIS MO.	TOTAL LIFE HOURS	BODY CURRENT	COMMENTS
26	TM	B1565	VARIAN	09608B	4A/SQ CM	5.12	2.09	10.70	24,323.6	42,388.9	41,628.3	760.6	25,084.2	4.0ma	
27	TM	B1667	VARIAN	12635A	4A/SQ CM	5.05	2.14	10.81	22,676.7	57,262.0	56,524.0	738.0	23,414.7	3.9ma	
28	TM	B1671	VARIAN	12631A	4A/SQ CM	5.30	2.13	11.29	21,800.2	73,437.3	72,674.8	762.5	22,562.7	5.0ma	
29	TM	B1672	VARIAN	12632B	4A/SQ CM	5.24	2.09	10.95	24,562.2	69,597.4	68,836.8	760.6	25,322.8	1.6ma	
30	RV	A002	VARIAN	12638B	4A/SQ CM	7.44	2.62	19.49	19,200.8	65,239.0	64,478.3	760.7	19,961.5	1.0ma	
31	RV	A003	VARIAN	12641A	2A/SQ CM	6.10	2.30	14.03	20,054.8	47,656.9	46,896.2	760.7	20,815.5	1.6ma	
32	RV	A005	VARIAN	12643A	2A/SQ CM	6.64	2.49	16.53	20,152.5	8,655.0	7,894.2	760.8	20,913.3	0.7ma	
33	RV	A006	VARIAN	12640A	4A/SQ CM	7.00	2.44	17.08	19,513.9	64,958.5	64,197.7	760.8	20,274.7	2.1ma	
34	RV	A007	VARIAN	12640B	4A/SQ CM	7.27	2.56	18.61	19,509.2	63,335.0	62,574.2	760.8	20,270.0	0.8ma	
35	RV	A008	VARIAN	12641B	2A/SQ CM	6.67	2.37	15.81	20,011.1	50,577.3	49,816.6	760.7	20,771.8	0.3ma	
36	RV	A009	VARIAN	12643B	2A/SQ CM	6.26	2.24	14.02	19,294.6	48,261.2	47,500.4	760.8	20,055.4	0.5ma	
37	SC	208	F-D-E	12644A	1A/SQ CM	6.80	0.39	2.65	10,240.2	41,895.9	41,133.6	762.3	11,002.5	0.0ma	STARTED LIFE TEST 6/14/91

TOTAL LIFE HOURS OF CATHODES STILL ON TEST
AS OF THE END OF AUGUST.

CATHODE TYPE	TOTAL LIFE HRS.
MK	189,720.7
M	218,895.7
TL	55,581.5
MMM	611,361.5
TM	217,611.2
RV	143,062.2
SC	11,002.5
TOTAL LIFE HRS.	1,447,235.3

Table 3. Monthly Cathode Facility Report (Concluded)

RL/CATHODE FACILITY VEHICLE INVENTORY

T = TRUE (IRCON Two Color Pyrometer)
B = BRIGHTNESS (PYROMETER CORP.) Disappearing Filament Pyrometer.

CODES

a – Removed from test due to cathode bushing leakage.

b – Removed from test due to heater burnout.

c – Degradation in excess of 10%.

d – Removed for excessive body current.

e – Removed from test due to collector bushing leakage.

f – Removed from test, power supply needed for more promising type.

g– Return to Universal Energy Systems for repair.

h – Non-Cathode related failure.

i – Returned to F-D-E Enterprises for analysis.

Note: No information is available where non-annotated entries are evident.
Cathode degradation updated July 1992.

AUG. 1992

Table 4. RL/Cathode Facility Vehicle Inventory

THE RL/OCTP CATHODE FACILITY VEHICLE INVENTORY

	VEHICLE DATA				TEST CONDITION DATA		STATUS	DATE REMOVED	LIFE HRS. WHEN REMOVED	CODE	APPROXIMATE % DEGRADATION @ OPER. TEMP.	COMMENTS
	TYPE	MFR	S/N	LOAD DENSITY	DATE TEST STARTED	OPERATING TEMPERATURE						
1	MK	SIEMENS	2	2A/SQ CM	3/6/85	1020 DEG C B	ON TEST				-2.5	
2	MK	SIEMENS	3	4A/SQ CM		1060 DEG C B		12/1/88	12,949	d		Shipped To E. Wintucky (NASA-Lewis) 14 JAN 1992
3	MK	SIEMENS	4	4A/SQ CM	6/18/85	1060 DEG C B	ON TEST				-3.0	
4	MK	SIEMENS	6	2A/SQ CM		1020 DEG C B		7/13/89	20,414		-2.1	Shipped To E. Wintucky (NASA-Lewis) 14 JAN 1992
5	MK	SIEMENS	7	2A/SQ CM		1020 DEG C B		5/22/89	21,544	d	-1.1	Shipped To E. Wintucky (NASA-Lewis) 14 JAN 1992
6	MK	SIEMENS	8	4A/SQ CM	10/9/85	1060 DEG C B	ON TEST				-8.2	
7	MK	SIEMENS	12	2A/SQ CM	8/5/85	1020 DEG C B	ON TEST				-2.5	
8	MK	SIEMENS	17	4A/SQ CM	10/22/85	1060 DEG C B		5/21/91	35,672	c,d	-8.5	Shipped To E. Wintucky (NASA-Lewis) 14 JAN 1992
9	M	SEMICON	200	1A/SQ CM		938 DEG C B			26,951	f	-1.0	
10	M	SEMICON	201	1A/SQ CM		989 DEG C B			27,136	f	-3.0	
11	M	SEMICON	202	2A/SQ CM	7/17/84	1018 DEG C T	ON TEST				-8.3	
12	M	SEMICON	203	4A/SQ CM		1010 DEG C B			28,169	f	-0.3	
13	M	SEMICON	204	1A/SQ CM		1040 DEG C B	SHELF		16,026	f		
14	M	SEMICON	205	1A/SQ CM		989 DEG C B	SHELF		12,181	f		
15	M	SEMICON	209	2A/SQ CM	7/11/84	957 DEG C T	ON TEST				-2.0	
16	M	SEMICON	210	2A/SQ CM	6/25/90	960 DEG C T	ON TEST				-5.0	
17	M	SEMICON	215	2A/SQ CM	7/12/90	948 DEG C T	ON TEST				+0.5	
18	M	SEMICON	216	2A/SQ CM	7/18/90	945 DEG C T	ON TEST				-4.0	
19	M	HUGHES	211	4A/SQ CM		1040 DEG C T			22,145	h	-0.8	
20	M	HUGHES	212	4A/SQ CM	10/20/85	1013 DEG C T	ON TEST				-3.4	
21	M	HUGHES	214	4A/SQ CM		1030 DEG C T			13,036	h	-1.6	
22	TRI	VARIAN	001	2A/SQ CM		950 DEG C T			24,617	f	-0.2	
23	TRI	VARIAN	002	2A/SQ CM		955 DEG C T			1,270	h	-0.1	
24	TRI	VARIAN	005	4A/SQ CM		1000 DEG C T			275	h		Returned from UES. Roll off shows poor performance.
25	TRI	VARIAN	006	4A/SQ CM		990 DEG C T			1,200	h	0.0	
26	TRI	VARIAN	007	4A/SQ CM	6/21/89	995 DEG C T	SHIPPED		23,144	d		
27	TRI	VARIAN	008	4A/SQ CM		1000 DEG C T			241	h	0.0	Returned from UES in pieces.
28	TRI	VARIAN	009	4A/SQ CM	8/29/89	990 DEG C T			22,867	d	-3.5	Returned from UES, no heater current.
29	TRI	VARIAN	010	2A/SQ CM		960 DEG C T	SHELF		20,202	f	-0.2	
30	TRI	VARIAN	011						41	e		Returned from UES in pieces.
31	TRI	VARIAN	012	4A/SQ CM	9/17/85	985 DEG C T	ON TEST				-1.2	
32	TRI	VARIAN	013						37	h		
33	TRI	VARIAN	014	2A/SQ/CM		950 DEG C T			17,561	f	-0.8	Returned from UES. Roll off shows poor performance.
34	MMM	VARIAN	116	1A/SQ CM	5/21/91	969 DEG C T	ON TEST	7/14/88	48,862	f	0.0	Extension of prior test

Table 4. RL/Cathode Facility Vehicle Inventory (Con

THE RL/OCTP CATHODE FACILITY VEHICLE INVENTORY

	VEHICLE DATA				TEST CONDITION DATA		STATUS	DATE REMOVED	LIFE HRS. WHEN REMOVED	CODE	APPROXIMATE % DEGRADATION @ OPER. TEMP.	COMMENTS
	TYPE	MFR	S/N	LOAD / DENSITY	DATE TEST STARTED	OPERATING TEMPERATURE						
35	MMM	VARIAN	118	1A/SQ/CM	5/20/91	994 DEG C T	ON TEST	7/14/88	43,514	f	-2.0	Extension of prior test
36	MMM	VARIAN	119	1A/SQ/CM	5/30/91	968 DEG CT	ON TEST	7/14/88	46,360	f	-1.0	Extension of prior test
37	MMM	VARIAN	120	2A/SQ CM	9/22/82	1018 DEG C T	ON TEST				+5.1	
38	MMM	VARIAN	121	2A/SQ CM	12/17/82	988 DEG C T	ON TEST				+4.0	
39	MMM	VARIAN	122	2A/SQ CM	3/1/83	1021 DEG C T	ON TEST				-2.2	
40	MMM	VARIAN	123	2A/SQ CM	12/18/82	1032 DEG C T	ON TEST				-8.0	
41	MMM	VARIAN	124	2A/SQ CM	1/14/83	994 DEG C T	ON TEST				-1.0	
42	MMM	VARIAN	125	2A/SQ CM	1/18/83	1010 DEG C T	ON TEST				-4.8	
43	MMM	VARIAN	126	4A/SQ CM		1070 DEG C T			14,635	h	-1.7	
44	MMM	VARIAN	127	4A/SQ CM		1125 DEG C T			1,482	c	-20.1	
45	MMM	VARIAN	128							a		
46	TM	VARIAN	B1135	4A/SQ CM	8/22/89	1002 DEG C T	ON TEST				-8.5	
47	TM	VARIAN	B1240	4A/SQ CM	10/31/89	988 DEG C T	ON TEST				-0.9	
48	TM	VARIAN	B1350	4A/SQ CM	8/23/89	989 DEG C T	ON TEST				-3.0	
49	TM	VARIAN	B1352	4A/SQ CM	11/1/89	999 DEG C T	ON TEST				-11.6	
50	TM	VARIAN	B1355	4A/SQ CM	8/15/89	1001 DEG C T		5/21/91	13,977	c	-10.9	Shipped to F-D-E Enterprises 5/29/91
51	TM	VARIAN	B1462	4A/SQ CM	8/9/89	977 DEG C T	ON TEST				-1.6	
52	TM	VARIAN	B1565	4A/SQ CM	8/25/89	976 DEG C T	ON TEST				-2.0	
53	TM	VARIAN	B1667	4A/SQ CM	8/25/89	1009 DEG C T	ON TEST				-4.0	
54	TM	VARIAN	B1671	4A/SQ CM	11/2/89	1013 DEG C T	ON TEST				-9.5	
55	TM	VARIAN	B1672	4A/SQ CM	8/16/89	990 DEG C T	ON TEST				-5.0	
56	RV	VARIAN	A002	4A/SQ CM	3/23/90	972 DEG C T	ON TEST				+0.4	
57	RV	VARIAN	A003	2A/SQ CM	3/12/90	928 DEG C T	ON TEST				-27.0	Decreased emissions following a power failure.
58	RV	VARIAN	A004						------	d		Shipped to E. Wintucky (NASA-Lewis) 14 Jan 1992, NEVER WORKED
59	RV	VARIAN	A005	2A/SQ CM	3/6/90	952 DEG C T	ON TEST				+3.0	
60	RV	VARIAN	A006	4A/SQ CM	3/19/90	968 DEG C T	ON TEST				+0.5	
61	RV	VARIAN	A007	4A/SQ CM	3/21/90	946 DEG C T	ON TEST				+1.0	
62	RV	VARIAN	A008	2A/SQ CM	3/14/90	933 DEG C T	ON TEST				-0.4	
63	RV	VARIAN	A009	2A/SQ CM	3/15/90	934 DEG C T	ON TEST				+4.0	
64	SCANDATE	F-D-E	200	1A/SQ CM	9/27/90	687 DEG C T		5/01/91	5,061	c	-90.1	Shipped to F-D-E Enterprises 13 May 91
65	OXIDE	F-D-E	201	1A/SQ CM	9/25/90	715 DEG C T		5/01/91	5,139	c	-63.1	Shipped to F-D-E Enterprises 13 May 91
66	SCANDATE	F-D-E	208	1A/SQ CM	5/14/91	733 DEG C T	ON TEST				-68.2	
67	SCANDATE	F-D-E	214	1A/SQ CM	10/3/90	755 DEG C T		5/01/91	4,918	c	-70.2	Shipped to F-D-E Enterprises 13 May 91
68	OXIDE	F-D-E	203									Shipped to F-D-E Enterprises 13 May 91 (Shorted)

Table 4. RL/Cathode Facility Vehicle Inventory (Continued)

THE RL/OCTP CATHODE FACILITY VEHICLE INVENTORY

	VEHICLE DATA				TEST CONDITION DATA		STATUS	DATE REMOVED	LIFE HRS. WHEN REMOVED	CODE	APPROXIMATE % DEGRADATION @ OPER. TEMP.	COMMENTS
	TYPE	MFR	S/N	LOAD / DENSITY	DATE TEST STARTED	OPERATING TEMPERATURE						
69	CD	VARIAN	130	2A/SQ CM		1050 DEG C T			90	h	0.0	
70	CD	VARIAN	131	2A/SQ CM		915 DEG C T	SHELF		12,120	f	-1.1	
71	CD	VARIAN	132	4A/SQ CM		960 DEG C T			12,109	f	-1.8	
72	CD	VARIAN	133	4A/SQ CM		960 DEG C T	SHELF		12,014	f	-1.0	
73	CD	VARIAN	134	1A/SQ CM		880 DEG C T	SHIPPED		14,054	f	-0.7	Shipped to NASA, Cleveland OH C/O Ed Wintucky 11/4/91
74	CD	VARIAN	135	2A/SQ CM		920 DEG C T	SHIPPED		15,020	f	-0.9	Shipped to NASA, Cleveland OH C/O Ed Wintucky 11/4/91
75	CD	VARIAN	136	2A/SQ CM		950 DEG C T	SHIPPED		11,982	f	-1.1	Shipped to NASA, Cleveland OH C/O Ed Wintucky 11/4/91
76	CD	VARIAN	138									Received Broken
77	CD	VARIAN	139	4A/SQ CM		990 DEG C T	SHIPPED		8,710	f	-1.4	Shipped to NASA, Cleveland OH C/O Ed Wintucky 11/4/91
78	CD	VARIAN	1400	2A/SQ CCM		950 DEG C T			12,017	f	-1.2	
79	CD	VARIAN	141	1A/CQ CM		900 DEG C T			80	h	0.0	Returned from UEB, not repairable.
80	CPD	HUGHES	206	4A/SQ CM		1045 DEG C T	SHELF	7/13/88	15,959	f	0.0	
81	CPD	HUGHES	207	2A/SQ CM		1000 DEG C T	SHELF	7/14/88	21,106	f	0.0	
82	CPD	HUGHES	129	1A/SQ CM		960 DEG C T			2,070	h	-5.8	
83	LABS	ORC	216	1A/SQ CM		1605 DEG C T	SHELF		14,477	f	0.0	
84	LABS	ORC	217	.667A/SQ CM		1605 DEG C T	SHELF		12,358	f	0.0	
85	B	VARIAN	101z	1A/SQ CM		1050 DEG C B			12,505	c	-10.2	
86	B	VARIAN	102z	2A/SQ CM		1120 DEG C B			6,398	h	-9.0	
87	B	VARIAN	103z	1A/SQ CM		1050 DEG C B			1,770	h	-0.7	
88	B	VARIAN	104z	1A/SQ CM		1050 DEG C B			24,654	f	-2.9	
89	B	VARIAN	105z	1A/SQ CM		1050 DEG C B			8,351	h	-0.2	
90	B	VARIAN	106z	2A/SQ CM		1080 DEG C B			22,012	f	-9.8	
91	B	VARIAN	107y	2A/SQ CM		1140 DEG C B			6,823	c	-12.1	
92	B	VARIAN	108x	2A/SQ CM		1080 DEG C B			20,438	c	-10.6	
93	B	VARIAN	109z	4A/SQ CM		1120 DEG C B			8,016	c	-11.6	
94	B	VARIAN	110z	4A/SQ CM		1140 DEG C B			2,318	h	-6.6	
95	B	VARIAN	111z	1A/SQ CM		1050 DEG C B			23,327	f	-4.5	
96	B	VARIAN	112x	2A/SQ CM		1060 DEG C B			1,322	h	0.0	
97	B	VARIAN	113x	2A/SQ CM		1090 DEG C B			3,724	h	-3.4	
98	B	VARIAN	114y	2A/SQ CM		1090 DEG C B			20,289	c	-10.1	
99	B	VARIAN	115z	2A/SQ CM		1100 DEG C B			13,956	c	-10.5	
100	B	VARIAN	117y	2A/SQ CM		1070 DEG C B			1,673	h	0.0	

Table 4. RL/Cathode Facility Vehicle Inventory (Continued)

THE RL/OCTP CATHODE FACILITY VEHICLE INVENTORY

VEHICLE DATA				TEST CONDITION DATA		STATUS	DATE REMOVED	LIFE HRS. WHEN REMOVED	CODE	APPROXIMATE % DEGRADATION @ OPER. TEMP.	COMMENTS
TYPE	MFR	S/N	LOAD / DENSITY	DATE TEST STARTED	OPERATING TEMPERATURE						

CATHODE FACILITY TOTAL LIFE HOUR SUMMARY

AS OF THE END OF AUGUST.

CATHODES REMOVED FROM TEST

CATHODE TYPE	TOTAL LIFE HRS.	
MK	30,579	
M	147,646	
TRI	111,455	
MMM	154,853	
TM	13,977	
RV	0	
SC	9,979	
OX	8,139	
CD	98,176	
CPD	39,135	
LAB6	28,835	
B	175,374	
Total Life Hrs.----------	873,148	(Cathodes off Test)
Total Life Hrs.----------	1,447,235	(Cathodes On Test)
	2,320,383	(TOTAL LIFE TEST HRS.)

Table 4. RL/Cathode Facility Vehicle Inventory (Concluded)

supply failures with the corrective actions taken. Also reported monthly were any changes in contract personnel and a man-hour and funding profile. Included in the monthly report were updated copies of the MONTHLY CATHODE FACILITY REPORT and the RL/CATHODE FACILITY VEHICLE INVENTORY. Copies of these two reports for the final month of this task are included with this report as Table 3 and Table 4 respectively.

2.3 Biyearly

The periodic power supply calibrations and roll-offs are scheduled for twice a year. At each of these times each power supply receives a full calibration and the particular cathode they support receives a roll off performance check following the calibration. The data from the roll off is then used to create a Miram curve which gives a visual presentation of the cathode's performance. The procedures for the calibrations, roll-offs and Miram curves can be found in the ARC final report for Task 032, titled CATHODE LIFE PREDICTION. The RL technical report number for this report is RL-TR-91-321, dated December 1991.

3.0 UNSCHEDULED EVENTS

This section will describe the unscheduled events that occurred during the performance of this effort. It will include the power outages that occurred, the power supply malfunctions and the corrective actions taken, and the test vehicle changes that were performed.

3.1 Power Outages

During the time period August 2, 1991 to September 2, 1992, there were 19 recorded instances of prime power interruptions. These power interruptions caused the instantaneous shut down of 392 individual power supplies. In each case it was necessary to bring each individual power supply back on line following the procedure detailed in RL-TR-91-321.

3.2 Power Supply Malfunctions

In the year prior to the period of this task there were 19 power supply failures caused by component failures. This year showed a marked improvement with only 12 instances of power supply failures being caused by component failure. This improvement in reliability may just be coincidence but last year's effort of remounting all the cooling blowers with three bolts instead of just two, greatly reducing the vibration, may have contributed to this decrease in failures. The failed power supplies and the components requiring replacement are shown in Table 5.

3.3 Test Vehicle Activity

During the period of performance of this task there were no new vehicles delivered to RL or placed on life test. Five vehicles were shipped to Universal Energy Systems (U-E-S)

Power Supply Failures

Power Supply	Corrective Action
CO12628B	Replaced U2 on "A" Metering Card
CO12632B	Replaced U2 on "A" Metering Card
CO12632A	Replaced Blown Fuse F2
CO12631B	Replaced R8 on "A" Metering card
CO12643A	Replaced Hour Meter (Running Backwards)
CO12632A	Replaced PS-2 (No Output)
CO12629B	Replaced Defective Cathode current Meter
CO12629B	Replaced AC/DC Power Adapter (Noisy Output)
CO12638A	Replaced T7 Cathode Current Sensor (No Output)
CO12640B	Replaced C5 (Leaky) on High Voltage Relay Control Board
CO12641B	Replaced 28VDC power supply (noisy)
CO12635A	Replaced defective body current meter

Table 5. Power Supply Failures

located in Beaverton, OR. U-E-S attempted to disassemble and refurbish these vehicles. When returned to RL only two vehicles, Trilayer #05A and Trilayer #014A, had been reassembled. Two vehicles, Trilayer #008A and CD #141, were returned in pieces labeled not repairable. The fifth vehicle, Trilayer #009A, was returned labeled open heater. Test vehicles Trilayer #05A and #014A were placed on test and a roll-off was performed on each and Miram curves were produced. The Miram curves were discussed with the RL Cathode Lab supervisor who decided both vehicles should be removed from life test.

A total of nine test vehicles were shipped to NASA Lewis Cleveland, Ohio. They were vehicles # CD 133, CD 134, CD 135, CD 139, MK-3, MK-6, MK-7, MK-17 and RVA-004. These vehicles had been furnished to RL by NASA and had since been removed from life test.

4.0 DATA BASE

4.1 Long-Term Degradation Plots From Daily Readings

For the initial attempt to produce long term performance plots it was decided to plot the recorded daily cathode current readings, an indication of a cathode's emission at its life test operation temperature, against time. The first cathode selected was a reservoir type as the recording of daily readings, initiated in June of 1989, was prior to this group of cathodes being placed on life test. Realizing each cathode would have in excess of 600 data points it was decided to average each week's readings reducing the number of data points to about 120. Using LOTUS 1-2-3, a spreadsheet was developed that would automatically calculate the weekly averages and the percent of initial current as the daily readings were entered. The percent of initial current figures would eventually be used to create the long term performance plots. Upon completion of the data entry into the LOTUS spreadsheet the resulting percent of initial current figures were imported into another LOTUS spreadsheet which is shown in Table 6. This spreadsheet lists each cathode's weekly average percent of initial current. This spreadsheet also averages together the 2Amps(A)/Square(SQ) Centimeter(CM) cathodes and the 4A/SQ CM cathodes. These averages were then used to produce a single graph, shown in Figure 5.1, displaying the average performance of the 2A/SQ CM cathodes and the 4A/SQ CM cathodes. This graph was created by importing these figures into TECH-GRAPH-PAD Ver.4.0, a plotting and presentation software package.

4.2 Long-Term Degradation Plots From Miram Curves

Realizing that in order to produce meaningful degradation plots the technique used to measure periodic performance would have to be the same through-out the life test time period, it was decided to base the performance plots on information obtained from the six month periodic roll-offs. Since roll-offs had been taken on each cathode since the beginning of life testing, it would be possible to extract at least one data point every six months for each cathode for as long as the cathode had been on life test.

WEEKLY AVERAGED PERCENT OF INITIAL CATHODE CURRENT READINGS

TGP DATA POINT	RVA005 AT 2A/SQ CM	RVA008 AT 2A/SQ CM	RVA009 AT 2A/SQ CM	RVA002 AT 4A/SQ CM	RVA006 AT 4A/SQ CM	RVA007 AT 4A/SQ CM	2A/SQ CM CATHODE AVERAGES BY WEEK	2A/SQ CM EXPORTABLE FIGURES	4A/SQ CM CATHODE AVERAGES BY WEEK	4A/SQ CM EXPORTABLE FIGURES
1	100.12	100.12	100.70	100.20	100.11	100.10	100.31	100.31	100.14	100.14
2	100.04	100.24	101.00	100.28	102.00	100.20	100.43	100.43	100.83	100.83
3	100.12	99.90	101.24	100.48	99.16	100.58	100.42	100.42	100.07	100.07
4	100.54	99.90	101.06	100.30	99.08	100.60	100.50	100.50	99.99	99.99
5	100.32	100.04	101.02	99.98	97.30	100.64	100.46	100.46	99.31	99.31
6	100.24	99.92	101.08	100.20	98.58	100.66	100.41	100.41	99.81	99.81
7	100.28	100.00	100.10	99.90	99.90	100.50	100.13	100.13	100.10	100.10
9	100.00	100.00	100.95	100.07	99.83	100.90	100.32	100.32	100.27	100.27
10	100.00	99.74	100.97	99.98	99.63	101.03	100.24	100.24	100.21	100.21
11	100.32	99.14	100.64	99.70	99.76	100.25	100.03	100.03	99.90	99.90
12	100.24	99.18	98.95	99.65	99.85	100.35	99.46	99.46	99.95	99.95
13	100.34	99.04	99.22	99.73	99.98	100.23	99.53	99.53	99.98	99.98
14	99.90	99.08	98.87	99.60	100.00	99.87	99.28	99.28	99.82	99.82
15	99.94	99.22	99.00	99.92	99.64	100.48	99.39	99.39	100.01	100.01
16	100.00	99.34	99.14	99.60	99.88	100.58	99.49	99.49	100.02	100.02
17	99.90	99.12	98.93	99.58	101.60	100.50	99.32	99.32	100.56	100.56
18	99.78	99.06	98.90	99.68	102.36	100.66	99.25	99.25	100.90	100.90
19	99.98	99.22	99.05	99.70	103.67	100.68	99.42	99.42	101.35	101.35
20	99.70	99.18	99.08	99.24	102.68	100.67	99.32	99.32	100.86	100.86
21	99.10	99.14	99.04	99.58	99.20	100.64	99.09	99.09	99.81	99.81
22	99.40	99.24	98.96	99.62	99.60	100.52	99.20	99.20	99.91	99.91
23	99.82	99.12	99.14	99.63	99.54	100.80	99.36	99.36	99.99	99.99
24	99.92	99.46	99.58	99.65	99.72	100.83	99.65	99.65	100.07	100.07

Table 6. Weekly Averaged Percent of Initial Cathode Current Readings

TGP DATA POINT	RVA005 AT 2A/SQ CM	RVA008 AT 2A/SQ CM	RVA009 AT 2A/SQ CM	RVA002 AT 4A/SQ CM	RVA006 AT 4A/SQ CM	RVA007 AT 4A/SQ CM	2A/SQ CM CATHODE AVERAGES BY WEEK	2A/SQ CM EXPORTABLE FIGURES	4A/SQ CM CATHODE AVERAGES BY WEEK	4A/SQ CM EXPORTABLE FIGURES
25	99.88	99.48	99.43	99.60	99.58	101.03	99.60	99.60	100.07	100.07
26	100.24	99.02	99.40	99.70	99.78	100.85	99.55	99.55	100.11	100.11
27	100.32	99.50	99.34	99.62	100.04	100.64	99.72	99.72	100.10	100.10
28	100.54	99.56	99.18	99.86	100.02	100.82	99.76	99.76	100.23	100.23
29	100.56	99.52	99.18	99.95	100.20	100.72	99.75	99.75	100.29	100.29
30	100.58	99.54	99.16	100.00	100.24	100.76	99.76	99.76	100.33	100.33
31	100.60	99.44	99.04	99.98	100.26	100.76	99.69	99.69	100.33	100.33
32	100.54	99.22	99.04	99.92	100.34	100.94	99.60	99.60	100.40	100.40
33	100.52	99.26	98.72	99.88	100.28	100.88	99.50	99.50	100.35	100.35
34	100.34	99.26	98.76	99.98	100.20	100.84	99.45	99.45	100.34	100.34
35	100.56	99.48	98.84	99.98	100.30	101.00	99.63	99.63	100.43	100.43
36	100.88	99.26	99.24	99.83	100.26	101.13	99.79	99.79	100.40	100.40
37	100.70	99.56	99.08	100.58	100.24	100.94	99.78	99.78	100.59	100.59
38	100.76	99.56	99.32	100.20	100.38	101.16	99.88	99.88	100.58	100.58
39	100.78	99.50	99.24	100.14	100.72	101.12	99.84	99.84	100.66	100.66
40	100.92	99.48	99.24	100.05	100.62	100.94	99.88	99.88	100.54	100.54
41	100.78	99.40	98.88	99.73	100.62	97.38	99.69	99.69	99.24	99.24
42	100.48	99.62	98.80	100.00	100.67	98.07	99.63	99.63	99.58	99.58
43	100.64	99.64	98.98	100.16	100.80	100.40	99.75	99.75	100.45	100.45
44	100.84	99.50	99.16	100.04	100.88	100.50	99.83	99.83	100.47	100.47
45	100.96	99.26	99.08	99.86	100.88	100.56	99.77	99.77	100.43	100.43
46	100.70	99.48	98.90	99.98	100.37	100.00	99.69	99.69	100.12	100.12
47	100.8c	99.44	98.98	100.10	100.98	100.34	99.76	99.76	100.47	100.47
48	100.88	99.36	99.00	99.86	101.00	100.20	99.75	99.75	100.35	100.35
49	100.74	99.38	98.92	99.57	100.58	100.10	99.68	99.68	100.08	100.08
50	100.94	99.96	99.04	100.30	101.00	100.04	99.98	99.98	100.45	100.45
51	101.30	99.84	99.62	100.13	100.94	100.46	100.25	100.25	100.51	100.51
52	101.42	100.04	99.88	100.30	99.58	100.93	100.45	100.45	100.27	100.27
53	101.46	99.78	100.12	100.31	100.12	101.34	100.45	100.45	100.59	100.59
54	101.46	99.70	100.04	100.07	100.08	101.22	100.40	100.40	100.46	100.46

Table 6. Weekly Averaged Percent of Initial Cathode Current Readings (Continued)

TGP DATA POINT	RVA005 AT 2A/SQ CM	RVA008 AT 2A/SQ CM	RVA009 AT 2A/SQ CM	RVA002 AT 4A/SQ CM	RVA006 AT 4A/SQ CM	RVA007 AT 4A/SQ CM	2A/SQ CM CATHODE AVERAGES BY WEEK	2A/SQ CM EXPORTABLE FIGURES	4A/SQ CM CATHODE AVERAGES BY WEEK	4A/SQ CM EXPORTABLE FIGURES
55	101.42	99.70	99.88	100.32	99.78	100.80	100.33	100.33	100.30	100.30
56	101.42	99.76	100.14	100.20	99.80	101.14	100.44	100.44	100.38	100.38
57	101.62	99.72	100.26	99.98	100.02	101.30	100.53	100.53	100.43	100.43
58	101.50	99.78	99.70	100.14	99.80	100.78	100.33	100.33	100.24	100.24
58	101.56	99.66	99.92	100.18	100.08	100.62	100.38	100.38	100.29	100.29
60	101.52	99.78	99.74	100.60	100.02	101.36	100.35	100.35	100.66	100.66
61	101.58	99.72	100.00	100.50	100.16	101.08	100.43	100.43	100.58	100.58
62	101.70	100.06	100.22	100.30	100.14	101.36	100.66	100.66	100.60	100.60
63	101.42	100.02	100.00	100.63	99.65	101.40	100.48	100.48	100.56	100.56
64	101.50	99.84	100.23	100.27	99.73	100.50	100.52	100.52	100.16	100.16
65	101.58	99.82	100.10	100.10	99.68	101.30	100.50	100.50	100.36	100.36
66	101.28	99.66	100.24	100.45	99.64	102.10	100.39	100.39	100.73	100.73
68	101.52	99.94	99.65	100.13	99.63	100.40	100.37	100.37	100.05	100.05
69	101.38	99.76	100.10	100.07	99.98	99.93	100.41	100.41	99.99	99.99
70	101.54	99.96	100.28	100.10	100.10	100.90	100.59	100.59	100.37	100.37
71	101.54	100.06	100.28	100.18	99.25	100.48	100.63	100.63	99.97	99.97
72	101.30	100.04	100.30	100.32	100.30	101.22	100.55	100.55	100.61	100.61
73	101.50	100.00	100.32	100.48	100.34	101.32	100.61	100.61	100.71	100.71
74	101.52	99.74	99.85	100.18	99.50	101.28	100.37	100.37	100.32	100.32
75	101.74	99.74	100.24	100.50	100.36	101.38	100.57	100.57	100.75	100.75
76	101.46	99.78	100.30	100.43	100.44	102.04	100.51	100.51	100.97	100.97
77	101.48	99.80	99.73	100.26	100.53	102.37	100.34	100.34	101.05	101.05
78	101.32	100.16	100.64	100.27	100.52	101.96	100.71	100.71	100.92	100.92
79	101.24	100.40	100.13	100.32	100.53	98.03	100.59	100.59	99.63	99.63
81	101.38	100.20	100.02	100.03	100.38	101.70	100.53	100.53	100.70	100.70
82	101.32	100.44	100.16	99.94	100.68	100.97	100.64	100.64	100.53	100.53
83	101.52	99.82	99.80	100.00	100.84	101.20	100.38	100.38	100.68	100.68
84	101.56	100.24	99.86	100.02	100.28	101.74	100.55	100.55	100.68	100.68
85	101.74	100.00	99.86	100.14	101.06	101.78	100.53	100.53	100.99	100.99
86	101.62	100.06	99.98	100.13	101.08	103.08	100.55	100.55	101.43	101.43

Table 6. Weekly Averaged Percent of Initial Cathode Current Readings (Continued)

TGP DATA POINT	RVA005 AT 2A/SQ CM	RVA008 AT 2A/SQ CM	RVA009 AT 2A/SQ CM	RVA002 AT 4A/SQ CM	RVA006 AT 4A/SQ CM	RVA007 AT 4A/SQ CM	2A/SQ CM CATHODE AVERAGES BY WEEK	2A/SQ CM EXPORTABLE FIGURES	4A/SQ CM CATHODE AVERAGES BY WEEK	4A/SQ CM EXPORTABLE FIGURES
87	101.66	100.10	99.98	100.25	101.18	101.90	100.58	100.58	101.11	101.11
88	101.70	99.90	99.88	100.40	101.33	101.96	100.49	100.49	101.23	101.23
89	101.76	99.86	99.80	100.34	101.33	101.27	100.47	100.47	100.98	100.98
90	101.64	100.00	99.88	100.42	101.40	101.30	100.51	100.51	101.04	101.04
91	101.64	99.92	99.86	100.33	101.32	101.70	100.47	100.47	101.12	101.12
92	101.92	100.10	99.80	100.44	101.28	101.85	100.61	100.61	101.19	101.19
93	101.44	100.10	99.92	100.28	101.46	101.94	100.49	100.49	101.23	101.23
94	101.62	100.20	99.78	100.44	101.48	102.02	100.53	100.53	101.31	101.31
95	101.64	99.90	99.62	100.40	101.46	102.08	100.39	100.39	101.31	101.31
96	101.55	100.00	99.83	100.40	101.40	101.90	100.46	100.46	101.23	101.23
					101.40	102.10			101.75	101.75

Table 6. Weekly Averaged Percent of Initial Cathode Current Readings (Concluded)

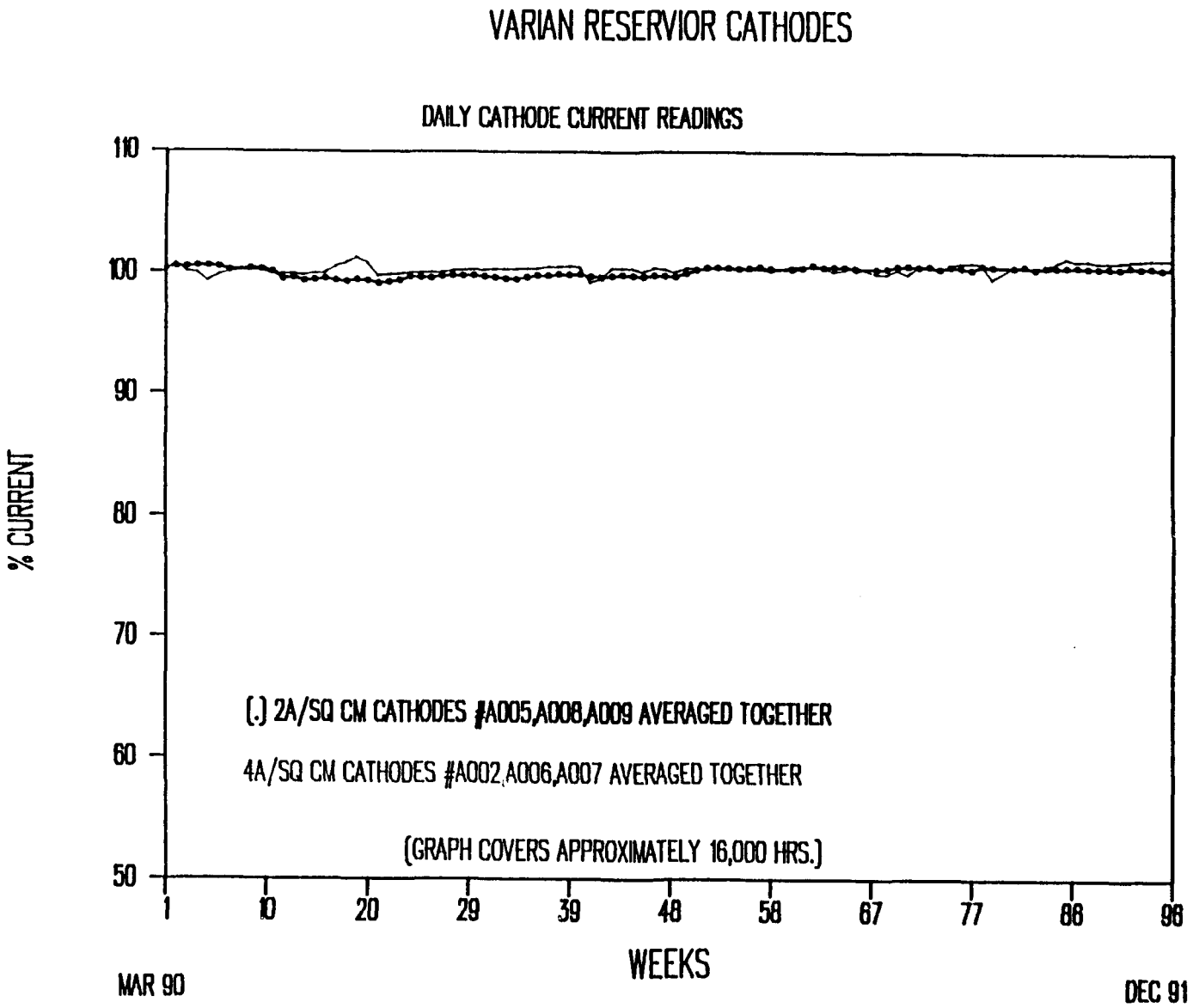

Figure 5-1. Varian Reservoir Cathode

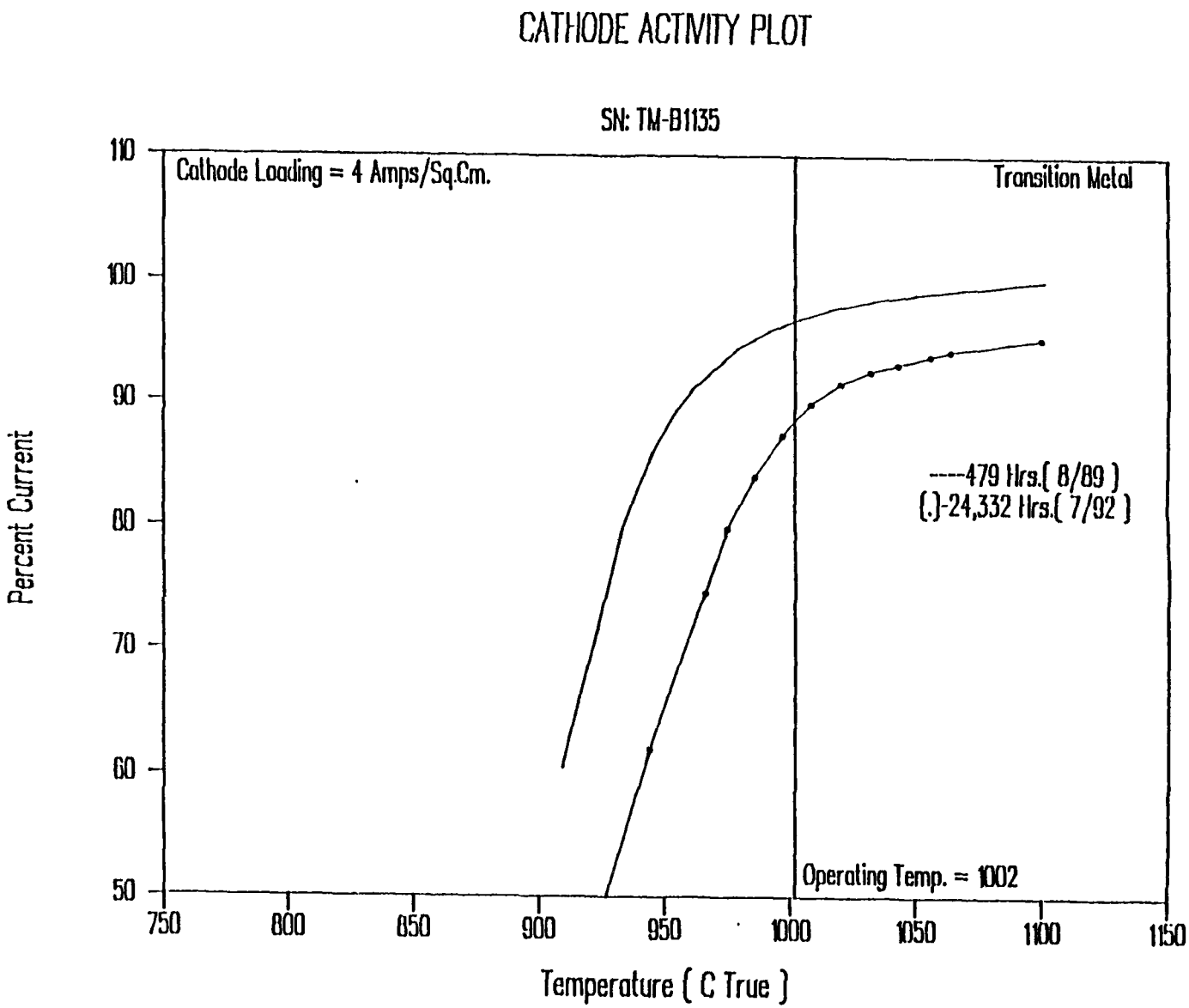

Figure 5-2. Sample Miram Curve

CATHODE LAB DATA BASE

for

2A/SQ CM CATHODES

M3DATA		BDATA		RVDATA		MKDATA		MDATA	
LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT
0	100	0	100	0	100	0	100	0	100
0	100	0	100	0	100	0	100	0	100
0	100	0	100	0	100	0	100	0	100
0	100	0	100	0	100	0	100	0	100
0	100	0	100	0	100	0	100	0	100
0	100	0	100	156	100	352	100	0	100
0	100	0	100	190	100	515	100	102	100
15	100	0	100	234	100	2356	100.5	1017	99.9
78	100	0	100	273	100	2869	99.5	1038	99
91	100	24	100	1323	100.7	2888	98.5	1116	100.8
155	100	41	100	1582	100.5	2978	100.6	2720	99.8
165	100	48	100	1592	98	4885	99.9	5327	99.5
171	100	50	100	1641	99.2	4939	101.5	5379	100.8
625	100	52	100	3374	99.2	5725	102	5530	97.5
1000	100	57	100	3626	101.4	5972	100	8957	98.4
1007	100	120	100	3760	96.2	11996	99.5	9055	100.8
1061	100	224	100	4230	101	15050	98.8	9722	96.5
1130	100	238	100	7969	95.4	15837	98.8	12919	100.4
1235	100	366	99.9	8121	101.4	16590	97.5	13017	97
1672	100	500	100	8165	99.5	18254	98.5	13142	94.8

Table 7. Cathode Lab Data Base

CATHODE LAB DATA BASE

for

2A/SQ CM CATHODES

M3DATA		BDATA		RVDATA		MKDATA		MDATA	
LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT
1700	100	801	98.9	8380	102	19984	99.2	12013	98.8
1980	99.9	850	100	11576	102.3	20415	97.5	13338	99.3
2295	100	851	99.8	11588	99	21149	97	21280	97
2340	100.2	1020	99.6	11834	102.5	21329	96.4	23196	96.1
2360	100	1065	98.4	15338	102	22245	100	24126	98.8
2750	100.1	1120	99.5	15455	99.7	24264	97.8	25574	96.9
2807	100	1185	100	15526	102	25306	99.9	29441	96
2850	100	1644	99			27525	96.7	32402	99.8
3961	100	2466	98.2			28639	98.8	32747	95.7
4050	100.3	2650	98.1			32922	96.7	36470	93.5
4510	100	2720	96.9			34154	98.9	37064	99.8
4515	99.7	2922	98			37399	95.9	40437	99.5
4555	100	3140	96.5			38248	99.5	44102	97.5
5430	100	3325	99			40236	98	44790	91.8
5440	100.1	3534	96.5			41247	98	48600	97.3
5441	99.9	3988	97.1					48894	90.7
5600	99.5	4700	93.3					52347	98.5
5650	100	4722	94.6					56087	98.1
5660	100.2	5630	96.2						
6440	100	6748	95.2						

Table 7. Cathode Lab Data Base (Continued)

CATHODE LAB DATA BASE

for

2A/SQ CM CATHODES

M3DATA		BDATA		RVDATA		MKDATA		MDATA	
LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT
6490	99.3	7140	94.7						
6690	99.6	7230	98						
6760	99.9	7540	92.1						
8015	100.1	8483	94.3						
8315	100	10164	93.2						
8470	99.5	11095	91						
8545	99.5	11435	96.4						
8700	99.9	14235	92.5						
8800	99	14762	88.8						
10320	100	15330	95						
10380	100	15430	91.5						
10445	99.5	18533	89.9						
10490	99.2	19327	85.5						
10890	99.4	20327	93.1						
11785	99.8								
11942	99.3								
12113	100								

Table 7. Cathode Lab Data Base (Continued)

CATHODE LAB DATA BASE

for

2A/SQ CM CATHODES

M3DATA		BDATA		RVDATA		MKDATA		MDATA	
LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT
12221	100.3								
12234	99.5								
12260	99								
13353	100								
13793	99.4								
14017	100								
14065	99.5								
14067	100.2								
14168	98.9								
15182	100								
17505	98.6								
18900	99								
19140	100								
19160	100.2								
19235	99.2								
19770	100								
24540	98								
26150	100								
26250	100.1								
26251	100								

Table 7. Cathode Lab Data Base (Continued)

CATHODE LAB DATA BASE

for

2A/SQ CM CATHODES

M3DATA		BDATA		RVDATA		MKDATA		MDATA	
LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT
26503	98.5								
26652	98.3								
37890	98.2								
39883	98.3								
39952	99.8								
40117	100								
40218	99.8								
40221	100								
40668	100								
41446	98.6								
42034	98								
42445	97.5								
43067	97.8								
44577	98.7								
44906	99.5								
44983	99.5								
45173	100								
45247	100.3								
45601	100.1								
45614	100.5								

Table 7. Cathode Lab Data Base (Continued)

CATHODE LAB DATA BASE

for

2A/SQ CM CATHODES

M3DATA		BDATA		RVDATA		MKDATA		MDATA	
LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT
46561	94								
46860	97.5								
47209	98								
48981	100								
49068	99.2								
49223	101								
49267	100.2								
50797	97.6								
50524	98								
52494	99.6								
52569	100								
52907	101.5								
52988	100								
53572	96								
54598	96.5								
55625	98.2								
56050	101.2								

Table 7. Cathode Lab Data Base (Continued)

CATHODE LAB DATA BASE

for

2A/SQ CM CATHODES

M3DATA		BDATA		RVDATA		MKDATA		MDATA	
LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT
56052	99.6								
56699	100								
57658	96.4								
58523	95								
60449	100.2								
60469	98.2								
60955	98.5								
61053	102.8								
62546	95.2								
62705	94								
64389	103								
64396	98.2								
64912	98.8								
65018	104								
66484	94.1								
66743	95								
68252	103								
68267	98								
68945	100								
69116	106								

Table 7. Cathode Lab Data Base (Continued)

CATHODE LAB DATA BASE

for

2A/SQ CM CATHODES

M3DATA		BDATA		RVDATA		MKDATA		MDATA	
LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT	LIFE TEST HOURS	% OF INITIAL CURRENT
70837	94								

NOTES:

NUMBER OF ZEROs IN THE FIRST COLUMN INDICATES THE NUMBER OF CATHODES IN EACH DATA FILE.

THE % OF INITIAL CURRENT IS DERIVED FROM THE PERIODIC MIRAM CURVES.

Table 7. Cathode Lab Data Base (Concluded)

The one thing that all Miram curves have in common is each plot shows the cathode's operating temperature as a vertical line referenced to the X axis (temperature). Each cathode's Miram curve crosses this operating temperature line. A sample curve is shown in Figure 5.2. Using a cathode's initial curve as a reference and designating the intersect of the curve with the operating temperature line as 100% initial current, each subsequent curve is referenced to the initial intersect point. The result of comparing a later curve to the initial curve is then expressed as a percent(%) of initial current. This comparison is repeated for all cathodes of a like type with the results being listed as well as the total life hours as shown on the Miram curve being used for the comparison. The preliminary results of this procedure looked promising so the comparisons were repeated for all cathodes on life test operating at 2A/SQ.CM. The results were then entered into a data base, shown in Table 7, created using LOTUS 123. The individual "X"(LIFE TEST HOURS) "Y"(% OF INITIAL CURRENT) data points were merged by entering the "Y" data points in ascending numerical order along with the corresponding "X" data point. All data points of an individual cathode type were then imported into the plotting software Tech-Graph-Pad (TGP). The graph shown in Figure 5.3 was then created in TGP. Each plot in the graph represents the composite performance of all cathodes of each type. In order to produce a comprehensive graph each individual data file was exponentially curve fit prior to plotting. The raw data as well as the resulting exponential curve fit for each type of cathode is shown in figures 5.4 thru 5.8.

The cathode degradation plots were delivered to RL and NASA Lewis. Both organizations transferred the graphs to view graphs for presentation at the 1992 TRI-SERVICE/NASA CATHODE WORKSHOP in Greenbelt, Maryland.

5.0 POWER SUPPLY REPAIR AREA AND SPARE PARTS CONTROL

5.1 Power Supply Repair Area

A storeroom (Cell 8A) located directly across from the Cathode Lab has been cleaned out and reorganized into a work area and spare parts storage area. All items previously stored in this area that weren't needed for lab support or that belonged to other laboratories have been removed. A work bench and two work tables were procured and moved into Cell 8A. When necessary to remove a failed power supply from its cabinet it can now be moved to Cell 8 for repair.

5.2 Spare Parts Control

Keeping an inventory of spare parts on hand avoids the downtime often encountered when parts need to be ordered. To identify power supply components requiring frequent replacement it is necessary to track how often failures occur and which components are being used most often. The power supply repair log, maintained in the lab, contains a record of power supply failures and corrective action including which parts were replaced and when but it does not indicate parts on hand. To keep track of the spare

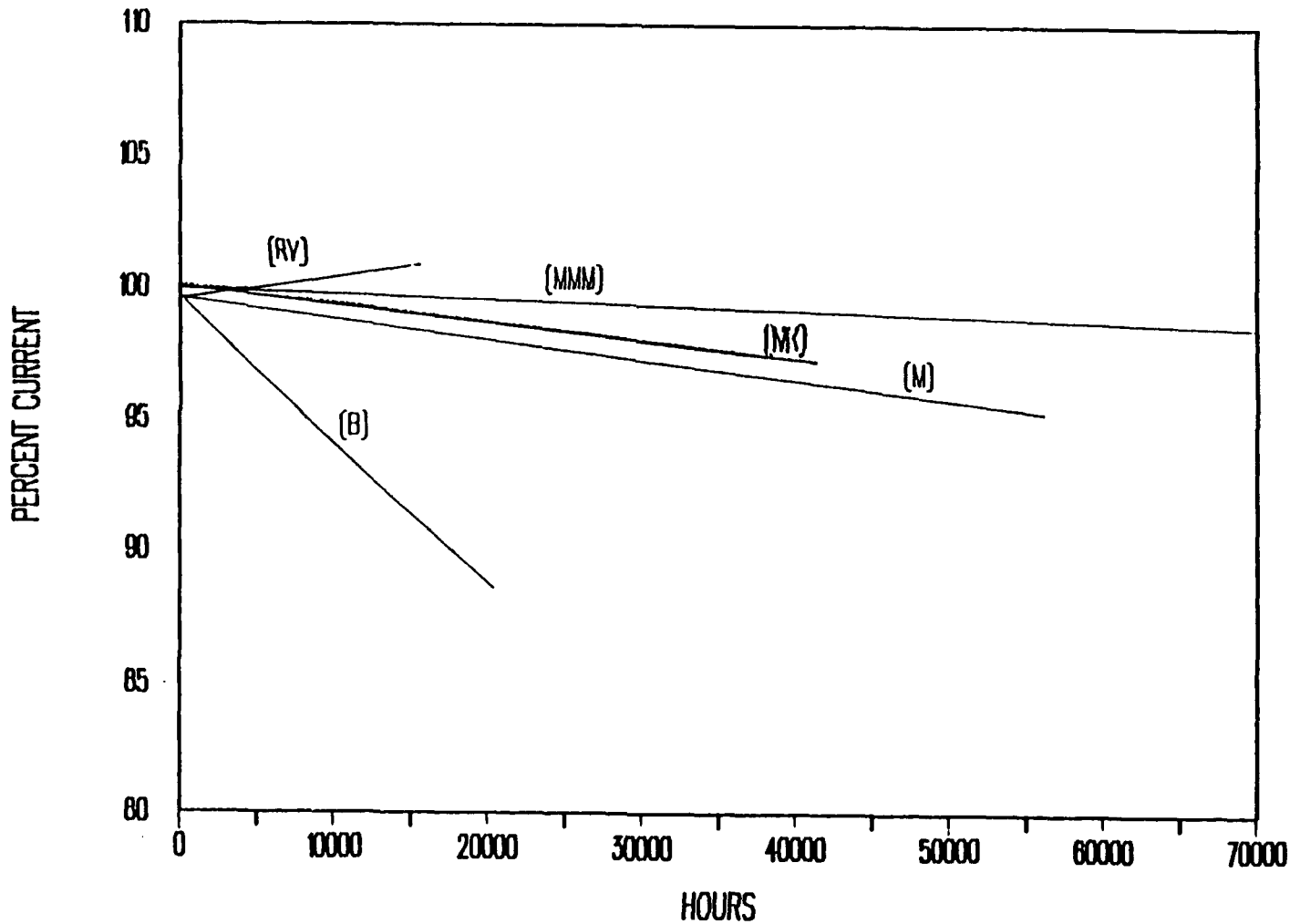

Figure 5-3. Cathode Degradation at 2A/SQ CM

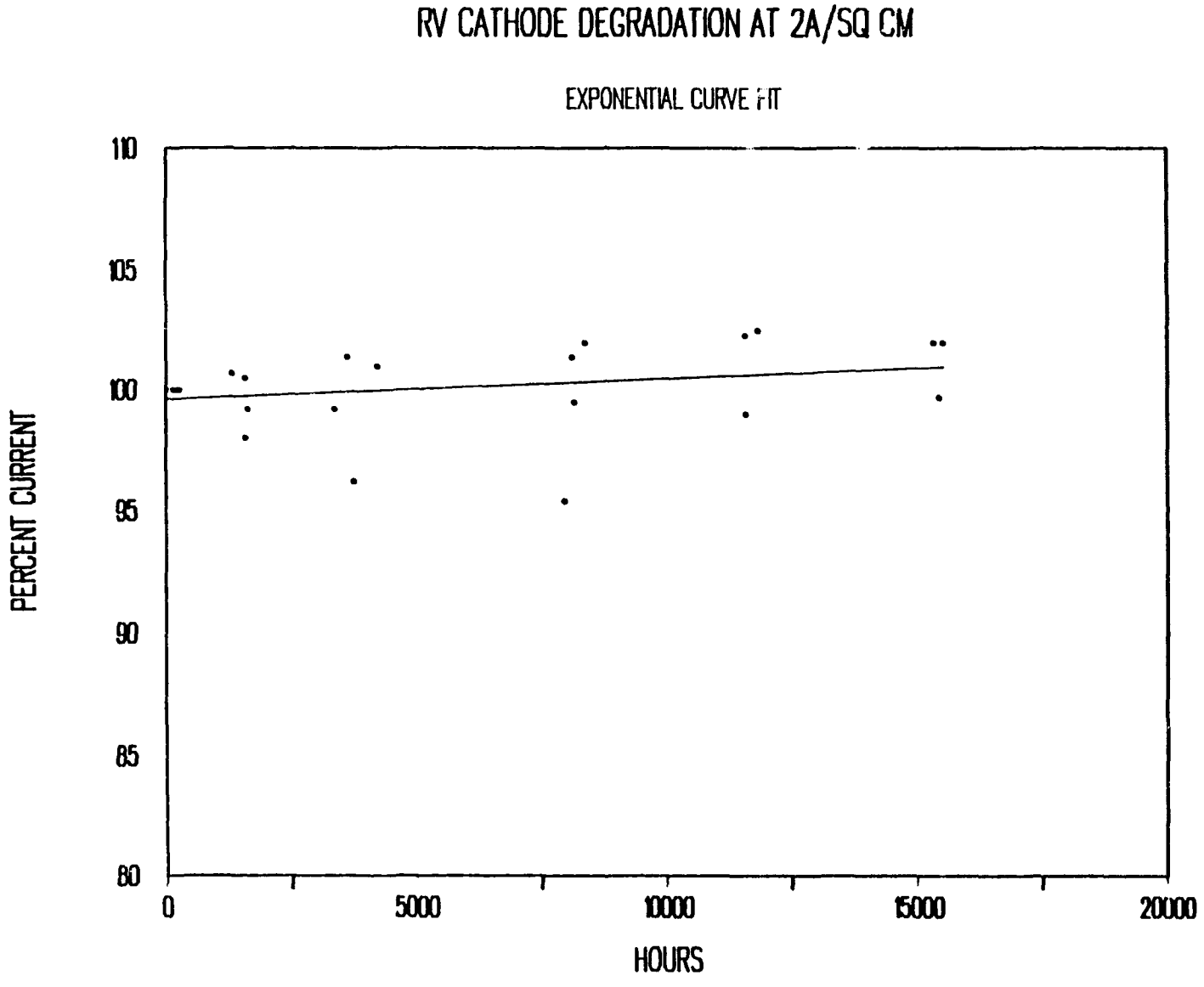

Figure 5-4. RV Cathode Degradation at 2A/SQ CM

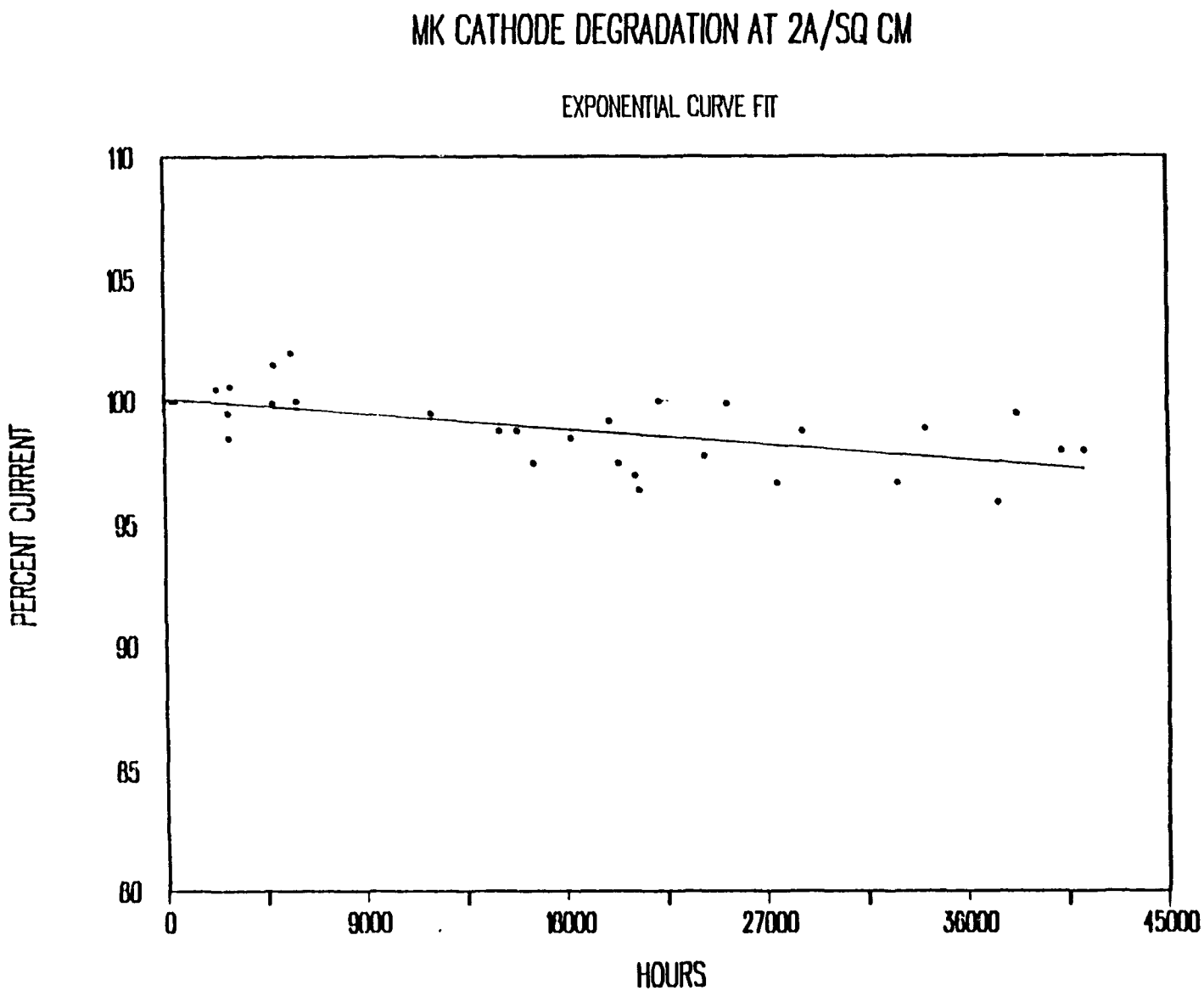

Figure 5-5. MK Cathode Degradation at 2A/SQ CM

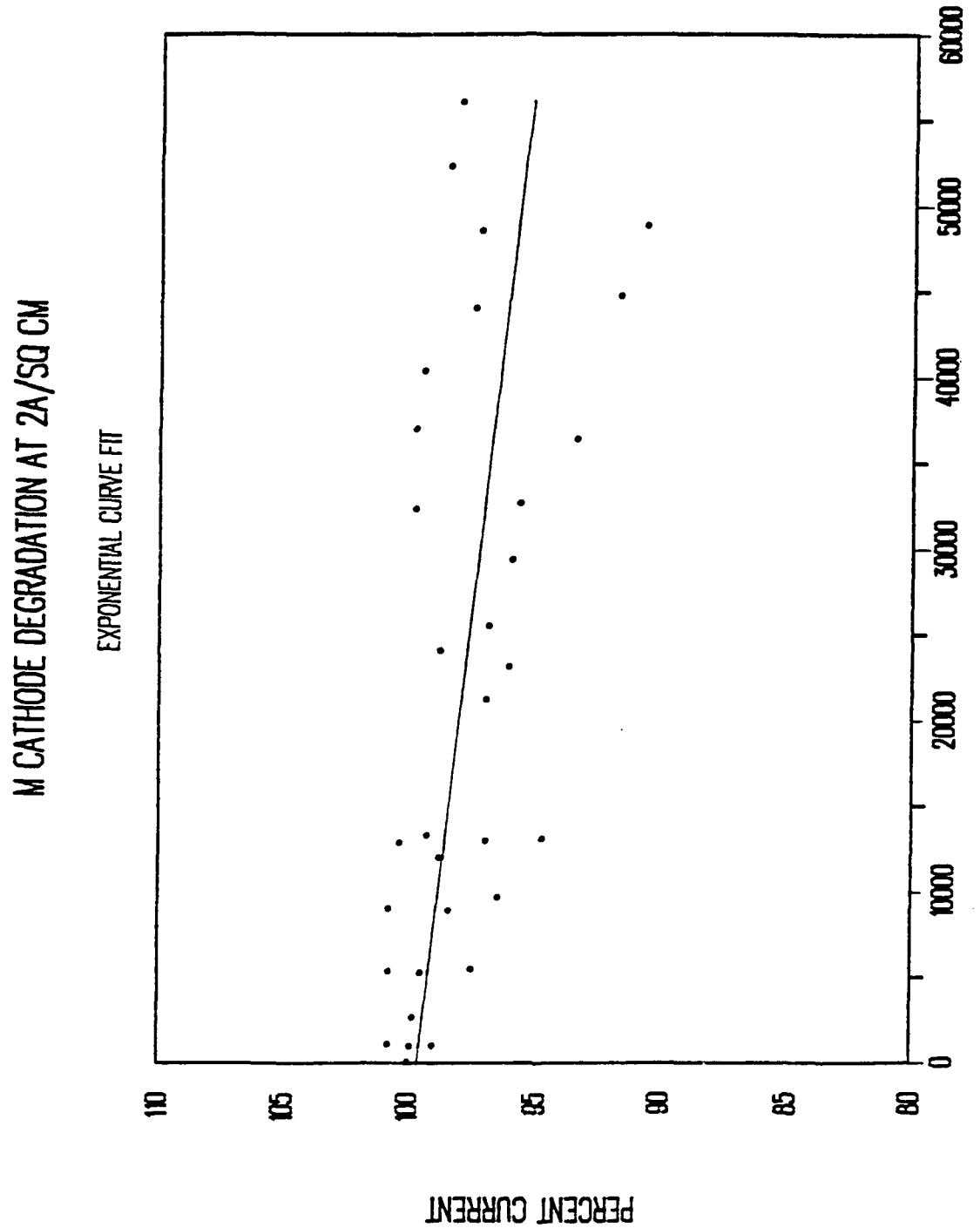

Figure 5-6. M Cathode Degradation at 2A/SQ CM

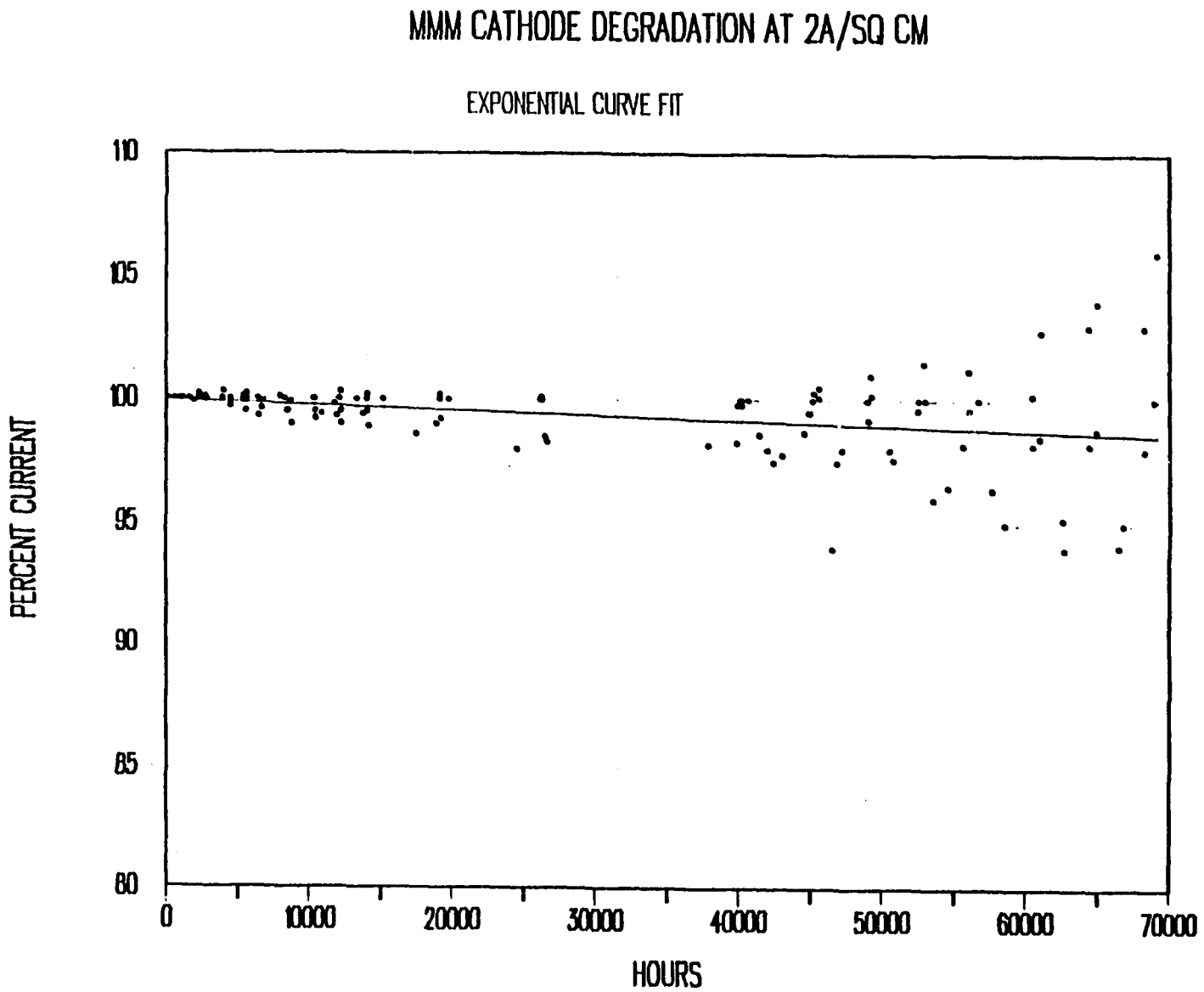

Figure 5-7. MMM Cathode Degradation at 2A/SQ CM

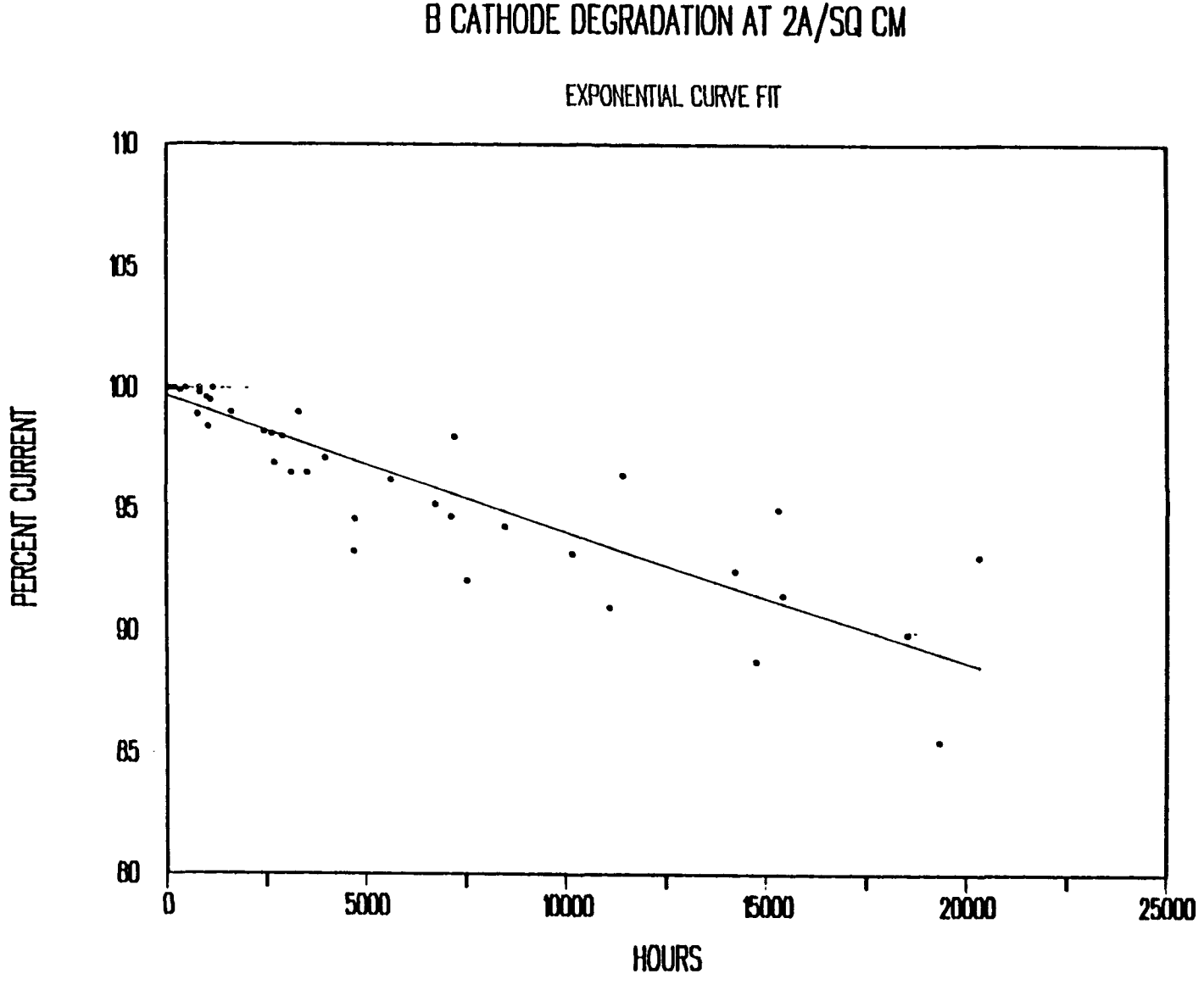

Figure 5-8. B Cathode Degradation at 2A/SQ CM

PARTS USAGE

PART NAME	SHELF	QTY	DATE	PART NAME	SHELF	QTY	DATE

Table 8. Parts Usage

CATHODE LAB PARTS INVENTORY

ITEM	MANUFACTURER	PART #	SHELF	QTY
BAG, PLASTIC			G5	
BANANNA JACK POST	HH SMITH	1517-107	A1	48
BLOWERS, COOLING W/FILTERS	BALDOR	33-1093-1362	G1-G4	12
CAPACITOR, 1MFD, 100VDC			A4	6
CAPACITOR, 50MFD, 50VDC	CDE		A4	9
CAPACITOR, 5MFD, 50VDC	SPRAGUE		A4	70
CAPACITOR, 80MFD, 450VDC	MALLORY	235-8312A	A4	4
CAPACITOR, .1MFD, 100VDC			A4	51
CAPACITOR, .1MFD, 600V	SPRAGUE	431P	B3	4
CAPACITOR, .1MFD, 600VDC	SPRAGUE		A4	53
CHOKE, 25/5 HENRIES	HOBART	C-732	B4	9
CHOKE, 25/5 HENRIES	TRIAD	C-33A	B4	9
CHOKE, 5-30 HENRIES	HOBART	C-766	B6	7
CIRCUIT BREAKER (DPDT)	POTTER & BLOOMFIELD	W92X11-2-15	A3	9
CLIPS, RESISTOR MOUNT			C2	
CONDITIONER, POWER 250KVA	MICRON	CVNN250KV15W	B5	8
CONNECTOR, EDGE, 30 PIN	UR	MP-0156-15-DP-1E	D2	156
CONNECTOR, JACK, 24 PIN	AMPHENOL	26-4401-24P	C1	4
CONNECTOR, PLUG, 24 PIN	AMPHENOL	26-4401-24S	C1	19
CONNECTOR, VAC-ION	AMPHENOL	97-310-GA-18-420S	D2	22
CURRENT SENSOR	AAC	903B-500	A2	12
DIODE		EC100	A3	5
DIODE	SYLVANIA	JAN1N4249	A4	23
DIODE		1N4007	A4	1000
DIODE		IN4005	A4	47
DIODE		JAN1N4249	A4	490
DIODE		EH400	A4	81
DIODE, ZENER 68V	SYLVANIA	ECG5092A	A4	97
DIODE, ZENER 6.8V	SYLVANIA	GEZD-6.8	A4	40
DISCHARGE ASSEMBLY	COBER		C6	5
FILTER, REACTOR (10 HENRIES)	TRIAD	C19A	A2	21
FILTER, REACTOR (12 HENRIES)	TRIAD	C-5X	C4	9
FRAME, VEH. TEST HOUSING			F1	3
FUSE HOLDER	BUSS	HKL-15A	A1	33
HANDLES	HH SMITH	1627	A1	24
HARDWARE, CABINET ASSEMBLY			G5	
HOUSING, TEST VEHICLES			G7	2
LENS, METER, RED	DYNAMIC SIENCES	(MOD. 73 METER)	D2	102
LIGHT, PANEL LAMP, 115V	DAILIGHT		D3	29
METERS, MISC			D1	
METER, 0-5A AC	SIMPSON	MODEL 55	C4	28
METER, DC MILLIAMPERS	LARSON	2.5 WV	E2	11
METER, HOUR 115V	SIMPSON	MODEL 55ET	C3	2
METER, HOUR 115V	CRAMER	10186	C3	15
METER, PANEL, DC VOLTS	DATEL	DM4101L	F1	3
METER, PANEL, DC VOLTS	DYNAMIC SCIENCES	MODEL 54	F2	61
METER, PANEL, DC VOLTS	DYNAMIC SCIENCES	MODEL 73	F3	71
PLUGS, AC			C4	5
POWER ADAPTER AC/DC	DATEL	UPA-5/500	A1	12
POWER MODULE AC/DC	ACOPIAN	DB15-10	A3	6
POWER MODULE AC/DC	ACOPIAN	28EB-15	A3	10
POWER SUPPLY	COBER		C6	4
POWER SUPPLY (5V)	ACOPIAN	RB200G705	B2	7
PUSH BUTTON	NEXUS	NX301CC1R	A1	55
PUSH BUTTON	NEXUS	NX301CC1B	A1	55
RELAY (3PDT)	CDE	323A10	C5	35

Table 9. Cathode Lab Parts Inventory

CATHODE LAB PARTS INVENTORY

ITEM	MANUFACTURER	PART #	SHELF	QTY
RELAY (3PDT)	POTTER & BLOOMFIELD	KRP14AG&DG	C5	32
RELAY (DPDT)	POTTER & BLOOMFIELD	KAP11AN	A3	79
RELAY (DPDT)	POTTER & BLOOMFIELD	KCP11	C5	30
RELAY (DPDT)	LINE ELECTRIC	AH-2A-115VAC	C5	24
RELAY (DPDT)	MAGNACRAFT	W88ANCPX-2	C5	20
RELAY, VACUUM, HIGH VOLTAGE	KILOVAC	H-11/S2	E1	20
RELAY,ELECTROMAGNET	MAGNACRAFT	W88ANCPX-2	A3	15
RESISTOR 8.2K			B3	16
RESISTOR 9.1K			B3	25
RESISTOR (100 OHM)		RC32GF	B3	32
RESISTOR (1.5K)	CLAROSTAT	VC3D	C2	10
RESISTOR (25 OHM)	CLAROSTAT	VC3D	C2	2
RESISTOR (470 OHM)	CLAROSTAT	VC3D	C2	6
RESISTOR (500 OHM)	CLAROSTAT	VC3D	C2	2
RESISTOR, 50 OHM, 1%	CLARO	VC3D	B3	4
RESISTOR, 100 WATT, 1K	OHMITE		C2	17
RESISTOR, 100 WATT, (100 OHM)	CLAROSTAT	VK100N	C2	2
RESISTOR, 100 WATT, (1K)	OHMITE	0609	C2	23
RESISTOR, 100 WATT, (20K)	CLAROSTAT	VK100N	C1	15
RESISTOR, 100 WATT, (50K)	OHMITE	0622	C2	5
RESISTOR, 100K, HIGH WATT	CLAROSTAT	VP25K	C2	45
RESISTOR, 1MEG PRESISION		M6721	B3	5
RESISTOR, 1%, 1MEG	CADDOCK		B3	50
RESISTOR, 1.02K	MEMCOR		B3	7
RESISTOR, 2 WATT, 120K			B3	36
RESISTOR, 3 WATT, 1K	CLAROSTAT	VC-3D	B3	3
RESISTOR, 3 WATT, 500 OHM			B3	4
RESISTOR, 4.99K	DALE		B3	250
RESISTOR, 5 WATT, 1MEG	OHMITE		B3	75
RESISTOR, 5 WATT, 8.2K	DALOHM		B3	6
RESISTOR, 50 WATT, (10K)	CLAROSTAT	VP50K	C1	11
RESISTOR, 50 WATT, (1K)	CLAROSTAT	VP50K	C1	7
RESISTOR, 50 WATT, (2K)	CLAROSTAT	VP50K	C2	5
RESISTOR, 510 OHM			B3	5
RESISTOR, 800 OHM	CLAROSTAT		B3	3
RESISTOR, HIGH WATT, 100 OHM	CLAROSTAT	VK100N	C2	10
RESISTOR, HIGH WATT, 10K OHM	CLAROSTAT	VP-50-K	C2	4
RESISTOR, HIGH WATT, 1MEG			B3	3
RESISTOR, POT 50 OHM	BOURNS		B3	8
RESISTOR, POT, 1K	BOURNS		B3	4
RESISTOR, POT, 1K	HAITI	961-20	B3	3
RESISTOR, POT, 1.2K	HAITI	961-20	B3	12
RESISTOR, POT, (2K)	CLAROSTAT	53C1-2K	C2	10
RESISTOR, PRECISION	CADDOCK	1787-6452	B3	16
RESISTOR, PRECISION	CADDOCK	1787-132	B3	39
RESISTOR, PRECISION (100 OHM)	CADDOCK	MS214	B3	16
RESISTOR, PRECISION (48 OHM)	CADDOCK	MS214	B3	70
RESISTOR, VOLTAGE SE			B3	11
RESISTOR, (680 OHM)	CLAROSTAT	VC3D	C2	10
SOCKET, PLUG IN	MAGNACRAFT	70-169	C5	5
SOCKET, RELAY, 11 PIN	AMERICAN PHENOLIC		A2	7
SOCKET, RELAY, 8 PIN	AMERICAN PHENOLIC	M-12883/01-02	A2	100
SOLENOID, 120VAC	GUARDIAN	A421-064142-01	C1	4
SPARK GAP	SIMCONA	CG90L	E1	13
STANDOFF	HH SMITH	NL523W01-008	D4	34
STANDOFF	HH SMITH	NL523W02-020	D4	69

Table 9. Cathode Lab Parts Inventory (Continued)

CATHODE LAB PARTS INVENTORY

ITEM	MANUFACTURER	PART #	SHELF	QTY
STANDOFF	HH SMITH	NL523W04-010	D4	161
STANDOFF	HH SMITH	NL523W02-006	D4	53
SWITCH, MICRO	CHERRY ELECTRIC	E23	C3	12
TERMINAL STRIP, 10 POSITION	CINCH		B1	46
TERMINAL STRIP, 12 POSITION	CINCH		B1	32
TERMINAL STRIP, 2 POSITION	TRW		B1	43
TERMINAL STRIP, 3 POSITION	TRW		B1	58
TERMINAL STRIP, 8 POSITION	TRW		B1	6
TRANSFORMER, FILAMENT 2.5V CT	TRIAD	F-1X	C4	33
TRANSFORMER, POWER	ELCOR	A518	A5	4
TRANSFORMER, POWER	ELCOR	A521	A6	12
TRANSFORMER, POWER	THORDARSON	21F09	A2	3
TRANSFORMER, POWER 10KV	ELCOR	A16	B6	18
TRANSFORMER, VARIABLE	POWERSTAT	10C	B2	39
TRANSFORMER, VARIABLE	POWERSTAT	TYPE 21	C4	13
VOLTAGE SENSOR (ADJUSTABLE)	POTTER & BLOOMFIELD	CSJ-38-70010	A3	8

Table 9. Cathode Lab Parts Inventory (Concluded)

parts on hand as well as when they were used, two forms have been created.

The first is the Parts Usage log shown in Table 8. This log will enable the lab operator to identify the frequency of parts usage. Periodic review of this log may help to predict a future need for a quantity of a particular part as occasionally the same part will fail in each supply at about the same time in operating hours.

The second form is the CATHODE LAB PARTS INVENTORY which is shown in Table 9. To get a accurate count of all the spare parts currently available it was necessary to remove all the parts from the shelves for sorting and counting. All the shelves were cleaned and location designators were placed on each section and shelf. All the parts were counted, organized and placed back on the shelves. All parts not required for lab support were turned in. The CATHODE LAB PARTS INVENTORY was then developed using LOTUS 1-2-3 Ver. 2.1 and ALWAYS Ver. 1.2. With this form the operator will always have up to data information on parts availability as well as a location guide.

6.0 FINAL ROLL OFFS AND MIRAM CURVES

During the Months of June and July of 1992 the scheduled semi-annual roll-offs were taken and a Miram curve for each cathode on life test was created. Prior to taking a roll off each power supply was calibrated. Shortly after calibration a roll-off was taken. The actual date of calibration for each power supply and actual date of roll-off for each cathode is given in Table 10. Using T-G-P the data obtained from the roll-off was then used to create an individual Miram curve for each cathode. Each cathode's Miram curve was plotted along with the cathode's original Miram curve, taken when the cathode was first placed on life test. Plotting the original curve and the latest curve on a single chart visually presents the changes in the cathode's performance. The point of measure of a cathode's performance is at its operating temperature, which is also shown on the graph. The change in emission at the operating temperature is expressed as percent of initial current. The latest Miram curve for each cathode on life test is shown in Figures 6.1 thru 6.35.

7.0 CATHODE PERFORMANCE MONITORING AND END OF LIFE DETERMINATION

At the present time a cathode that has degraded 5% at its operating temperature, as determined from a Miram curve, is said to have reached the end of useful life though most often they are left on life test until a replacement cathode becomes available. While experimenting with different techniques for producing long term performance graphs it was noticed the cathode degradation as determined from the cathode current meter reading on the power supplies would often times be different from the degradation as determined from the Miram curve. Since the cathode's life test conditions are selected to produce real life conditions it would make sense to use the cathode's current indication as

representative of day to day performance and to use the periodic Miram curves as more of a diagnostic tool than as the single indicator of change in performance or emission. If the cathode current reading were to be given status as a valid performance indicator then at any given moment the determination of a cathode's condition would be as simple as reading the cathode current meter on the front of the power supply. If these cathode current readings were recorded daily for the life of a cathode then these values could be plotted over the cathode's entire life span producing an extremely accurate long term graph of the cathode's performance. At the present time only two data points a year are available which are taken from the semi-annual roll-offs.

8.0 HUGHES AIRCRAFT COMPANY CATHODE LIFE TEST VEHICLES

In January of 1992 four cathode life test vehicles were ordered from Hughes Aircraft, 3100 W. Lomita Blvd., Torrance, CA 90509-2999. It was requested that these vehicles have scandate cathodes installed as Hughes was currently under contract to RL to develop scandate cathodes. When it was learned that the scandate development program would not be completed in time for Hughes to install scandate cathodes they were requested to install "M" type cathodes in place of the scandates. The cathode life test vehicles were to be designed in such a fashion that at a later date the "M" type cathodes could be removed and scandate cathodes installed in their place. On the 5th of August these vehicles were delivered to the Rome office of ARC Professional Services Group where they were checked for shipping damage and immediately delivered to RL. It was planned that these vehicles would be placed on life test prior to the expiration of the Task 034 TOA. Upon examination of the life test vehicles it became apparent that this was not going to be possible. The present test housings, that the test vehicles are installed in for life testing, are to small for the new test vehicles. To install the new vehicles would require a redesign and fabrication of the test housings. The new test vehicles were delivered with no mounting brackets which would also need to be fabricated.

In order to maintain the vacuum integrity of the life test vehicles they were connected to a vac-ion power supply. A fixture was built to hold the life test vehicles to prevent possible damage as their configuration allowed them to roll around. At the time of connection to the vac-ion power supply each vehicle seemed to be in good condition at least as far as maintaining vacuum. When voltage was applied each unit indicated about 50 ma vac-ion current. Within 2 minutes each vehicle had dropped to between 3 or 4 micro amps. Within 5 minutes each of the 4 units was indicating less than .01 micro amps.

METHODS OF DETERMINING CATHODE PERFORMANCE

	TYPE	S/N	MFR	P/S CO...	LOAD I DENSITY	FILAMENT E	FILAMENT I	FILAMENT WATTS	TOTAL LIFE HOURS	PERCENT CHANGE FROM INITIAL CURRENT: USING MIRAM CURVE (JULY 1992)	PERCENT CHANGE FROM INITIAL CURRENT: USING POWER SUPPLY CATHODE CURRENT READING
1	MK	2	SIEMENS	126298	2A/SQ CM	6.26	1.26	7.89	45,546.6	-2.5	-3.4
2	MK	4	SIEMENS	12628A	4A/SQ CM	6.22	1.31	8.15	48,253.4	-3.0	-1.8
3	MK	8	SIEMENS	126468	4A/SQ CM	6.32	1.35	8.53	47,183.9	-8.2	-6.6
4	MK	12	SIEMENS	126448	2A/SQ CM	5.33	1.22	6.50	45,677.9	-2.5	-.36
5	M	202	SEMICON	12645A	2A/SQ CM	5.50	2.25	12.38	51,695.0	-8.3	-6.75
6	M	209	SEMICON	126398	2A/SQ CM	4.88	2.14	10.44	61,231.7	-2.0	-0.5
7	M	210	SEMICON	12633A	2A/SQ CM	4.70	2.06	9.68	17,049.7	-5.0	-4.3
8	M	212	HUGHES	12634A	4A/SQ CM	5.80	2.28	13.22	49,881.9	-3.4	-3.5
9	M	215	SEMICON	126428	2A/SQ CM	4.54	2.04	9.26	17,330.2	+0.5	+0.2
10	M	218	SEMICON	126478	2A/SQ CM	4.72	2.05	9.68	17,164.4	-4.0	-1.7
11	TL	012	VARIAN	126338	4A/SQ CM	5.37	2.23	11.98	54,820.9	-1.2	+1.9
12	MMM	116	VARIAN	12637A	1A/SQ CM	5.20	2.11	10.97	59,237.6	0.0	+1.2
13	MMM	118	VARIAN	12629A	1A/SQ CM	5.25	2.11	11.08	52,769.9	-2.0	-0.4
14	MMM	119	VARIAN	126288	1A/SQ CM	5.00	2.16	10.80	56,252.6	-1.0	-0.2
15	MMM	120	VARIAN	12630A	2A/SQ CM	5.50	2.17	11.94	73,142.1	+5.1	+5.5
16	MMM	121	VARIAN	126308	2A/SQ CM	5.36	2.23	11.95	72,318.4	+4.0	+4.6
17	MMM	122	VARIAN	126348	2A/SQ CM	5.97	2.30	13.74	72,214.7	-2.2	-1.6
18	MMM	123	VARIAN	126378	2A/SQ CM	5.97	2.43	14.51	70,604.5	-6.0	-6.0
19	MMM	124	VARIAN	12638A	2A/SQ CM	5.55	2.40	13.32	73,038.5	-1.0	+0.5
20	MMM	125	VARIAN	12639A	2A/SQ CM	[illegible]	[illegible]	13.92	74,942.1	-4.8	-5.0
21	TM	B1135	VARIAN	126308	4A/SQ CM	5.30	2.0	10.86	24,570.5	-8.5	-8.6
22	TM	B1240	VARIAN	12636A	4A/SQ CM	5.40	2.23	12.04	21,026.7	-0.9	-1.1
23	TM	B1350	VARIAN	126318	4A/SQ CM	5.37	2.10	11.28	23,951.7	-3.0	-4.5
24	TM	B1352	VARIAN	126368	4A/SQ CM	5.43	2.29	12.43	23,243.2	-11.6	-9.8
25	TM	B1462	VARIAN	12632A	4A/SQ CM	5.30	2.06	10.92	24,655.7	-1.6	-1.3
26	TM	B1565	VARIAN	096088	4A/SQ CM	5.12	2.09	10.70	24,323.6	-2.0	-1.1
27	TM	B1667	VARIAN	12635A	4A/SQ CM	5.05	2.14	10.81	22,676.7	-4.0	-3.5
28	TM	B1671	VARIAN	12631A	4A/SQ CM	5.30	2.13	11.29	21,800.2	-8.5	-8.5
29	TM	B1672	VARIAN	126328	4A/SQ CM	5.24	2.09	10.95	24,562.2	-5.0	-3.6
30	RV	A002	VARIAN	126388	4A/SQ CM	7.44	2.62	19.49	19,200.8	+0.4	+0.1
31	RV	A003	VARIAN	12641A	2A/SQ CM	6.10	2.30	14.03	20,054.8		
32	RV	A005	VARIAN	12643A	2A/SQ CM	6.64	2.49	16.53	20,152.5	+3.0	+1.9
33	RV	A006	VARIAN	12640A	4A/SQ CM	7.00	2.44	17.08	19,513.9	+0.5	+0.2
34	RV	A007	VARIAN	126408	4A/SQ CM	7.27	2.56	18.61	19,509.2	+1.0	+2.3
35	RV	A008	VARIAN	126418	2A/SQ CM	6.67	2.37	15.81	20,011.1	-0.4	-0.1
36	RV	A009	VARIAN	126438	2A/SQ CM	6.26	2.24	14.02	19,294.6	+4.0	-0.6
37	SC	208	F-D-E	12644A	1A/SQ CM	6.80	0.39	2.65	10,240.2	-68.2	-65.8

Table 10. Methods of Determining Cathode Performance

MEASUREMENT DATE LOG SHEET

	TYPE	S/N	MFR	P/S CO.	LOAD I DENSITY	CALIBRATION DATE	ROLL OFF DATE
1	MK	2	SIEMENS	12629B	2A/SQ CM	25 JUN 92	25 JUN 92
2	MK	4	SIEMENS	12628A	4A/SQ CM	25 JUN 92	25 JUN 92
3	MK	8	SIEMENS	12646B	4A/SQ CM	25 JUN 92	25 JUN 92
4	MK	12	SIEMENS	12644B	2A/SQ CM	25 JUN 92	26 JUN 92
5	M	202	SEMICON	12645A	2A/SQ CM	09 JUL 92	10 JUL 92
6	M	209	SEMICON	12639B	2A/SQ CM	09 JUL 92	10 JUL 92
7	M	210	SEMICON	12633A	2A/SQ CM	09 JUL 92	09 JUL 92
8	M	212	HUGHES	12634A	4A/SQ CM	14 JUL 92	15 JUL 92
9	M	215	SEMICON	12642B	2A/SQ CM	14 JUL 92	15 JUL 92
10	M	218	SEMICON	12647B	2A/SQ CM	14 JUL 92	15 JUL 92
11	TRILAYER	012	VARIAN	12633B	4A/SQ CM	14 JUL 92	16 JUL 92
12	MMM	116	VARIAN	12637A	1A/SQ CM	06 JUL 92	06 JUL 92
13	MMM	118	VARIAN	12629A	1A/SQ CM	06 JUL 92	06 JUL 92
14	MMM	119	VARIAN	12628B	1A/SQ CM	06 JUL 92	06 JUL 92
15	MMM	120	VARIAN	12630A	2A/SQ CM	06 JUL 92	07 JUL 92
16	MMM	121	VARIAN	12635B	2A/SQ CM	06 JUL 92	08 JUL 92
17	MMM	122	VARIAN	12634B	2A/SQ CM	06 JUL 92	08 JUL 92
18	MMM	123	VARIAN	12637B	2A/SQ CM	06 JUL 92	08 JUL 92
19	MMM	124	VARIAN	12638A	2A/SQ CM	06 JUL 92	07 JUL 92
20	MMM	125	VARIAN	12639A	2A/SQ CM	06 JUL 92	07 JUL 92

Table 11. Measurement Data Log Sheet

MEASUREMENT DATE LOG SHEET

	TYPE	S/N	MFR	P/S CO.	LOAD I DENSITY	CALIBRATION DATE	ROLL OFF DATE
21	TM	B1135	VARIAN	12630B	4A/SQ CM	20 JUL 92	21 JUL 92
22	TM	B1240	VARIAN	12636A	4A/SQ CM	14 JUL 92	16 JUL 92
23	TM	B1350	VARIAN	12631B	4A/SQ CM	20 JUL 92	21 JUL 92
24	TM	B1352	VARIAN	12636B	4A/SQ CM	14 JUL 92	16 JUL 92
25	TM	B1462	VARIAN	12632A	4A/SQ CM	27 JUL 92	29 JUL 92
26	TM	B1565	VARIAN	09808B	4A/SQ CM	23 JUL 92	24 JUL 92
27	TM	B1667	VARIAN	12635A	4A/SQ CM	23 JUL 92	24 JUL 92
28	TM	B1671	VARIAN	12631A	4A/SQ CM	20 JUL 92	20 JUL 92
29	TM	B1672	VARIAN	12632B	4A/SQ CM	27 JUL 92	29 JUL 92
30	RV	A002	VARIAN	12638B	4A/SQ CM	29 JUN 92	29 JUN 9
31	RV	A003	VARIAN	12641A	2A/SQ CM	---	NO ROLL OFF LOW EMISSIONS
32	RV	A005	VARIAN	12643A	2A/SQ CM	29 JUN 92	30 JUN 92
33	RV	A006	VARIAN	12640A	4A/SQ CM	29 JUN 92	30 JUN 92
34	RV	A007	VARIAN	12640B	4A/SQ CM	29 JUN 92	30 JUN 92
35	RV	A008	VARIAN	12641B	2A/SQ CM	29 JUN 92	02 JUL 92
36	RV	A009	VARIAN	12643B	2A/SQ CM	29 JUN 92	29 JUN 92
37	SC	208	F-D-E	12644A	1A/SQ CM	---	NO ROLL OFF LOW EMISSIONS

Table 11. Measurement Data Log Sheet (Concluded)

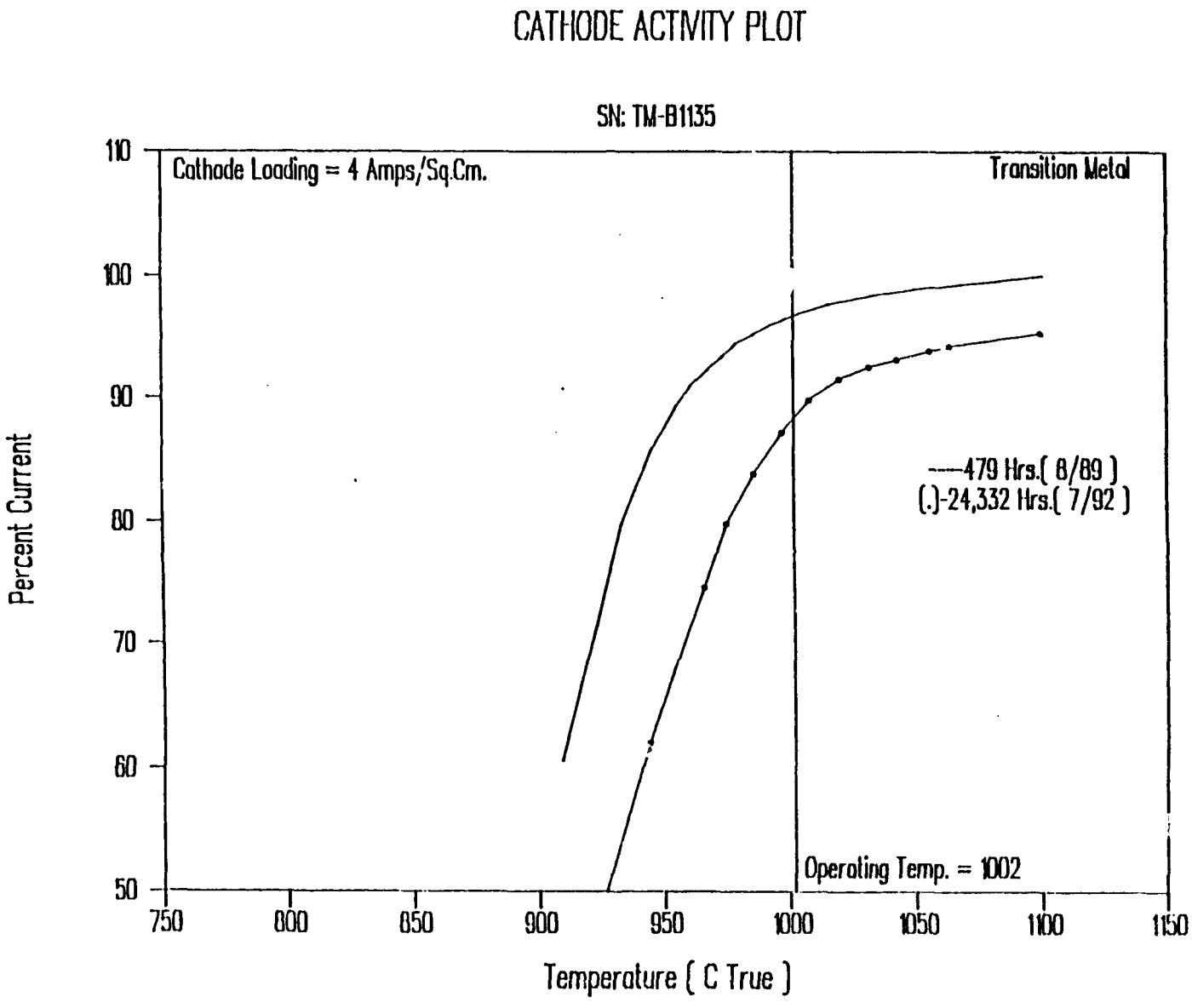

Figure 6-1. TM-B1135 Miram Curve

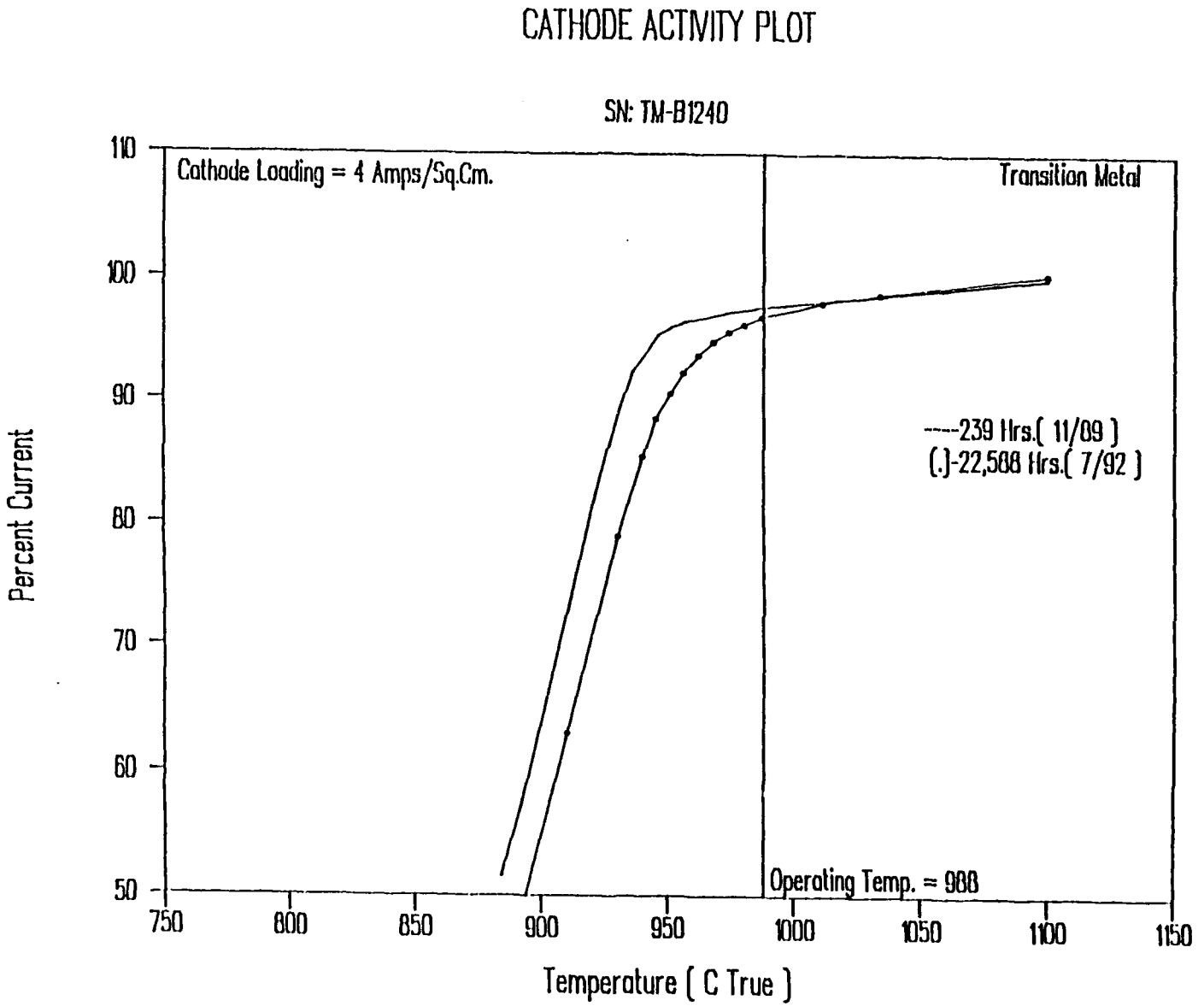

Figure 6-2. TM-B1240 Miram Curve

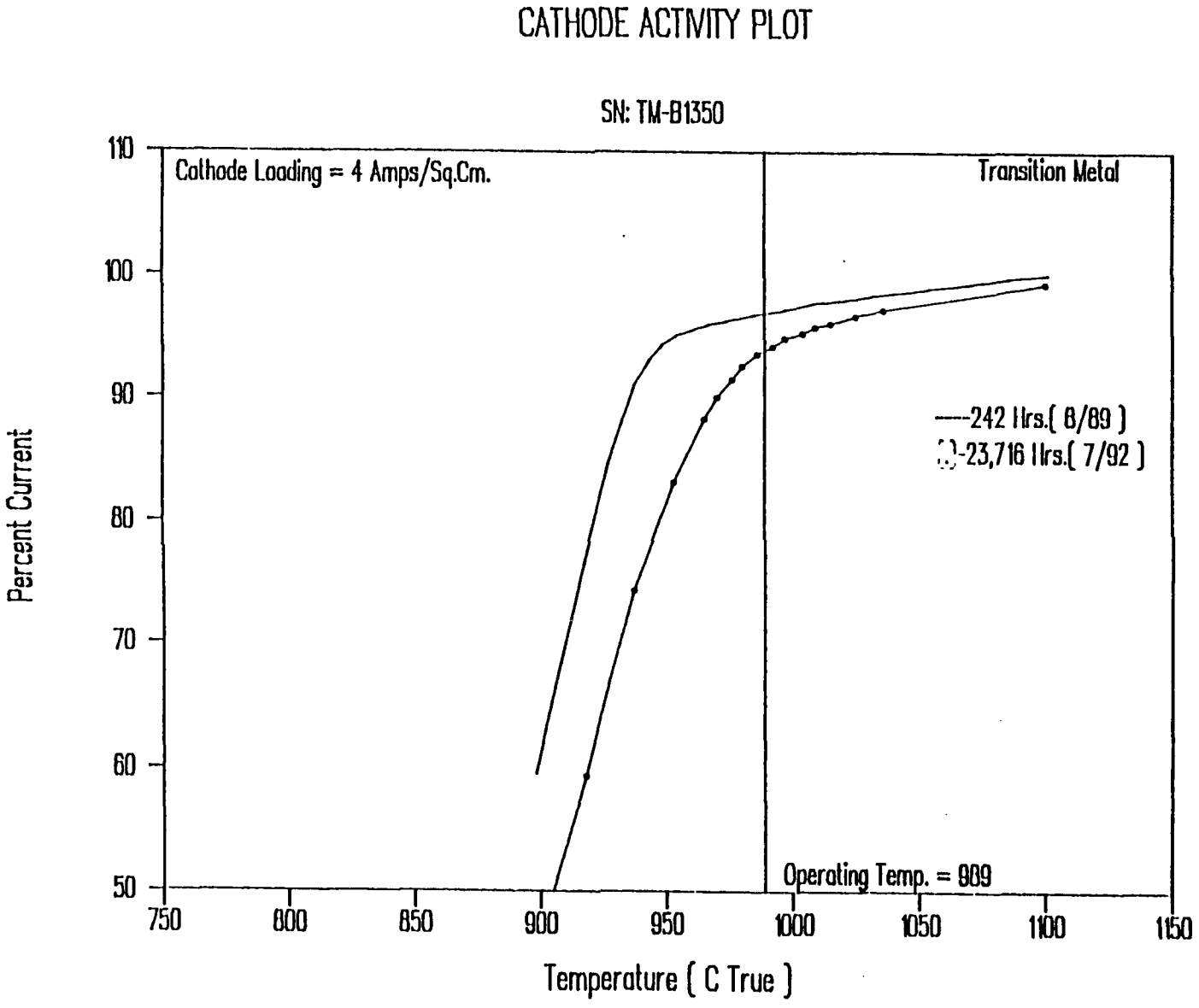

Figure 6-3. TM-B1350 Miram Curve

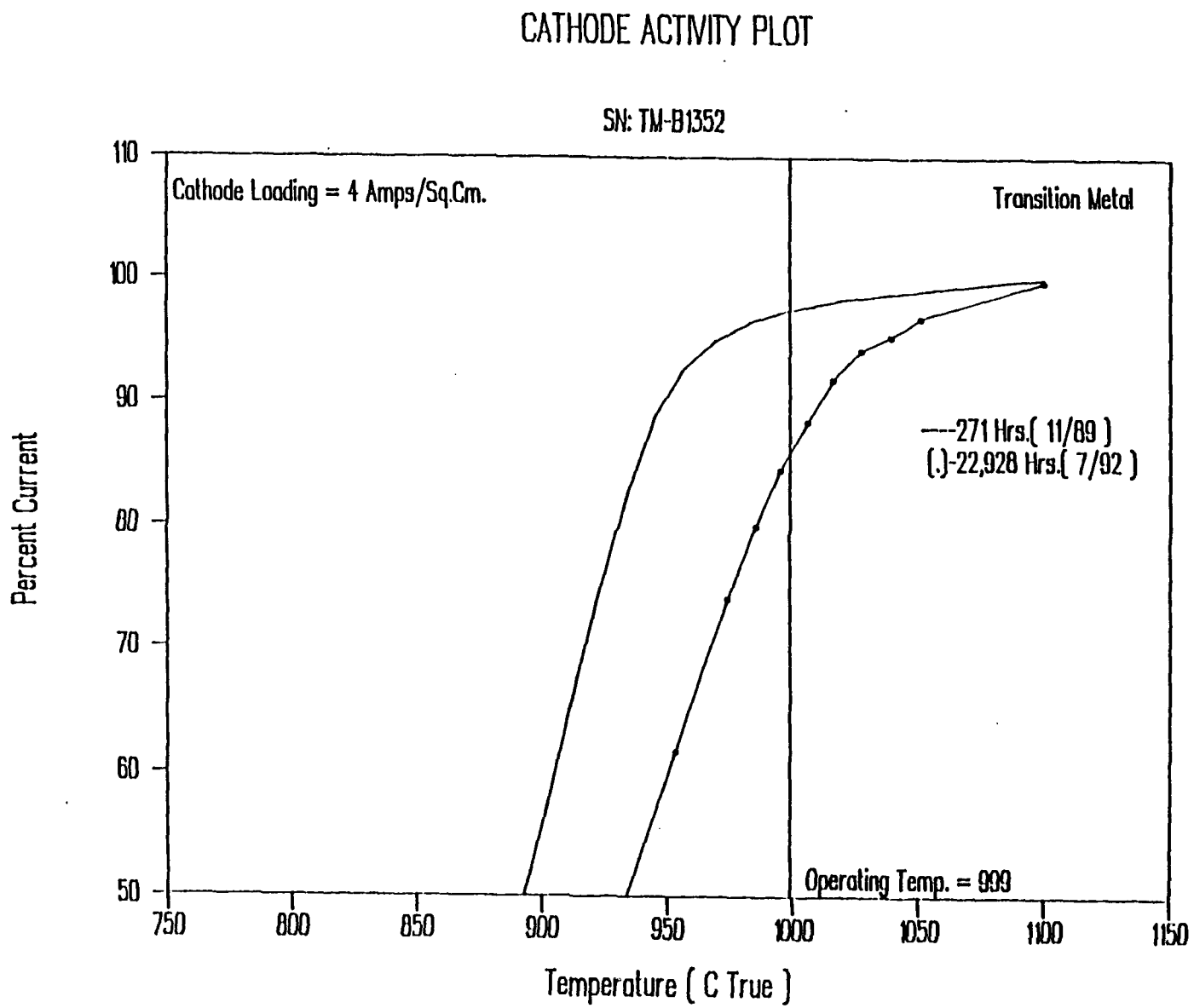

Figure 6-4. TM-B1352 Miram Curve

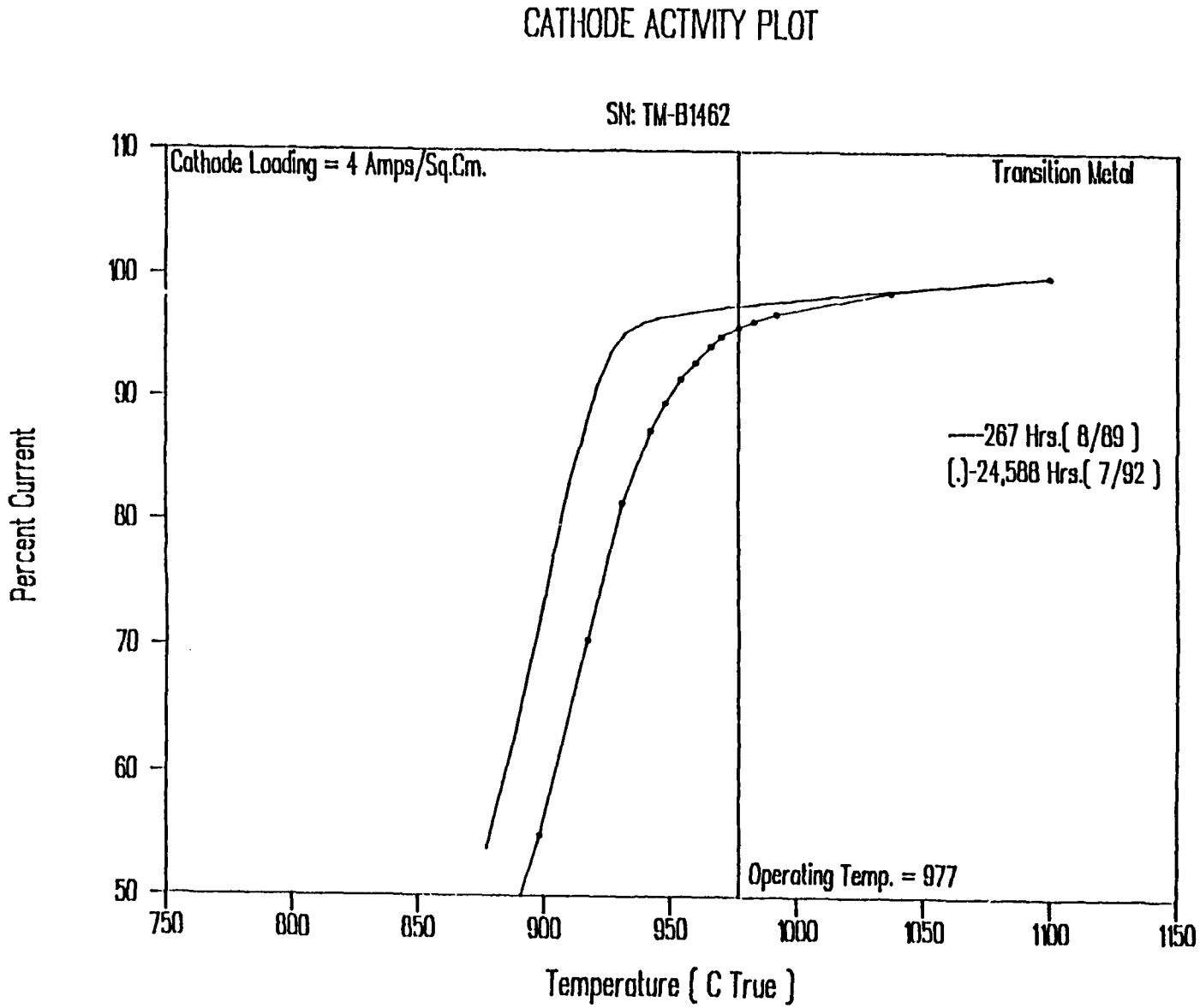

Figure 6-5. TM-B1462 Miram Curve

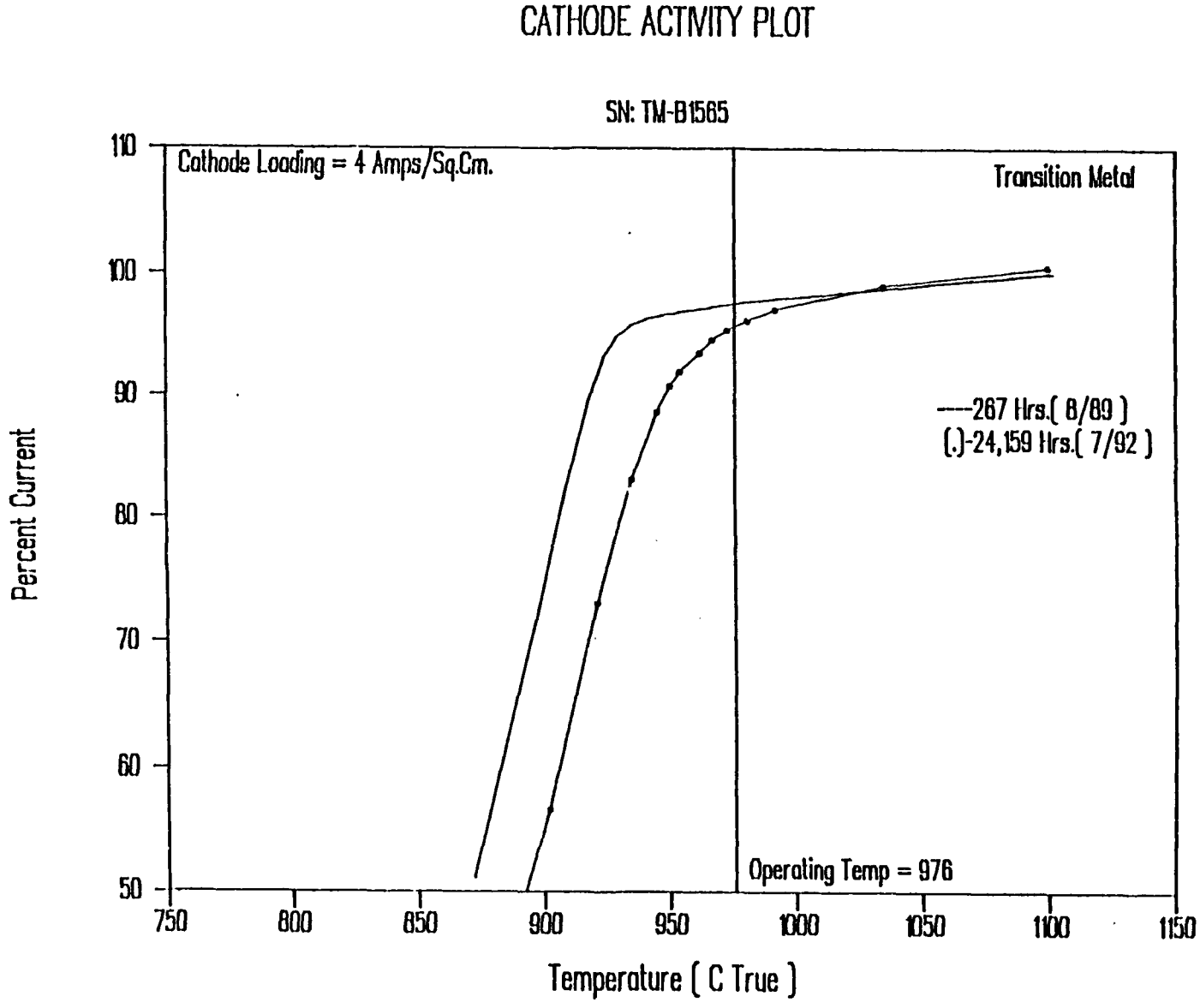

Figure 6-6. TM-B1565 Miram Curve

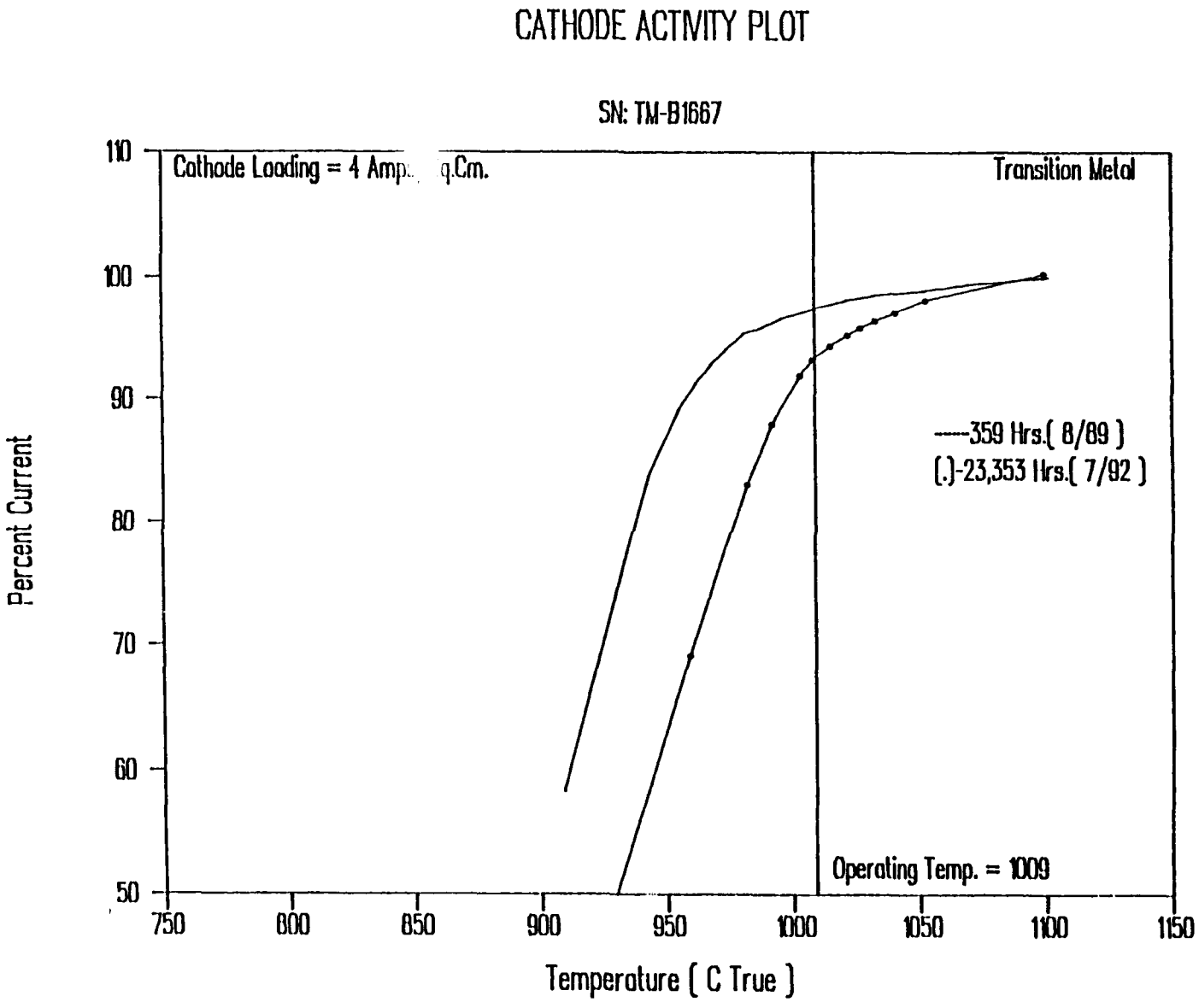

Figure 6-7. TM-B1667 Miram Curve

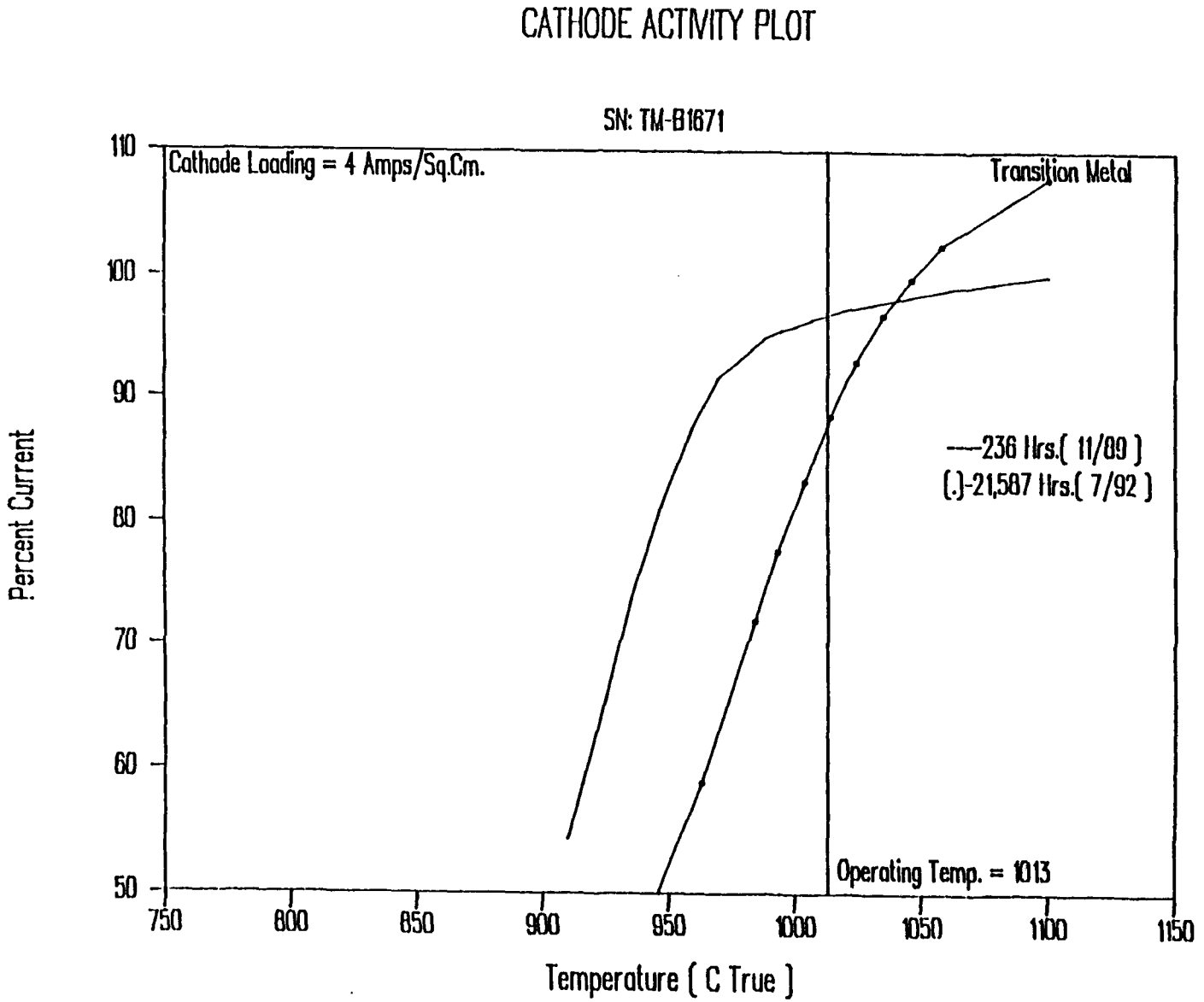

Figure 6-8. TM-B1671 Miram Curve

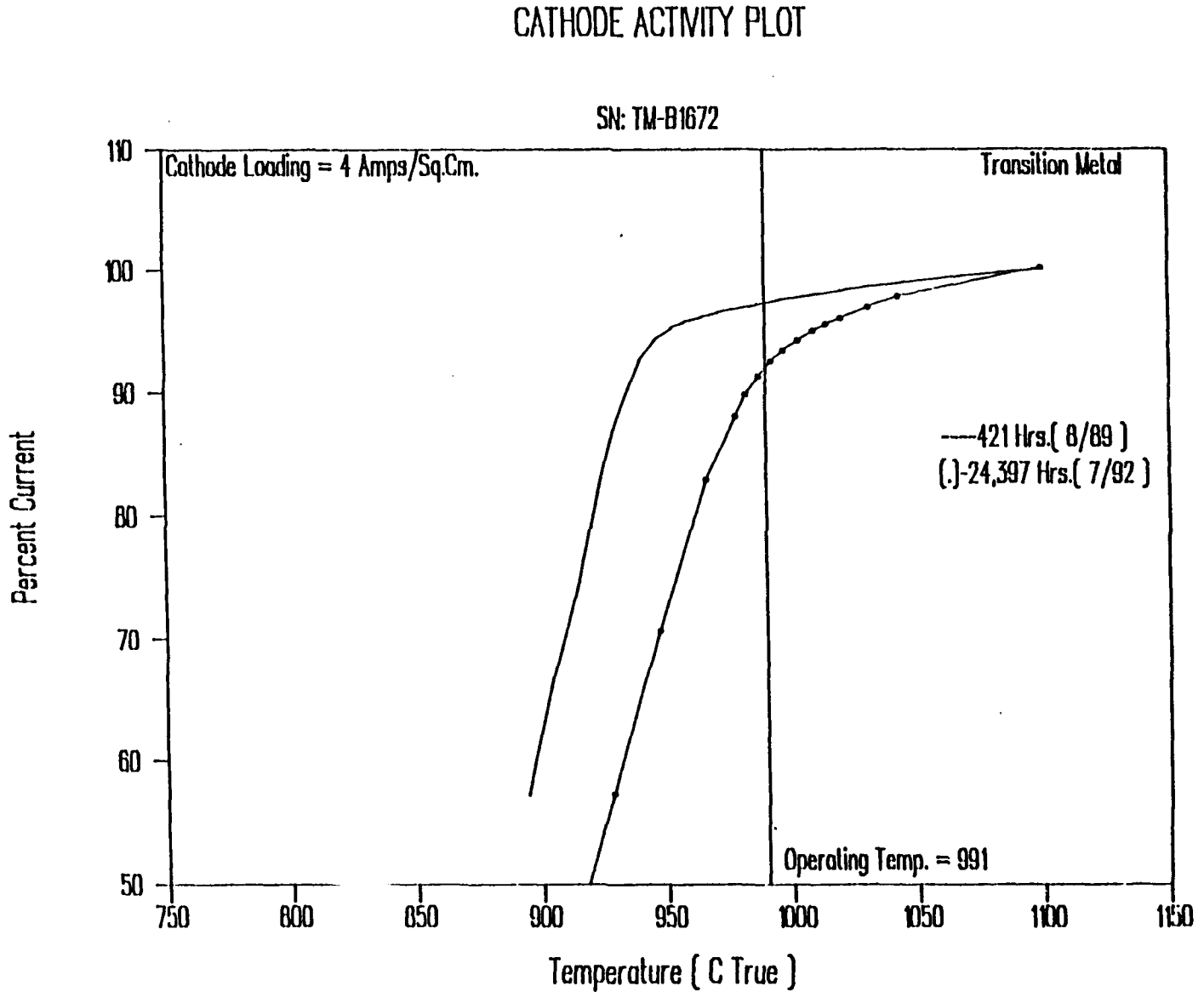

Figure 6-9. TM-B1672 Miram Curve

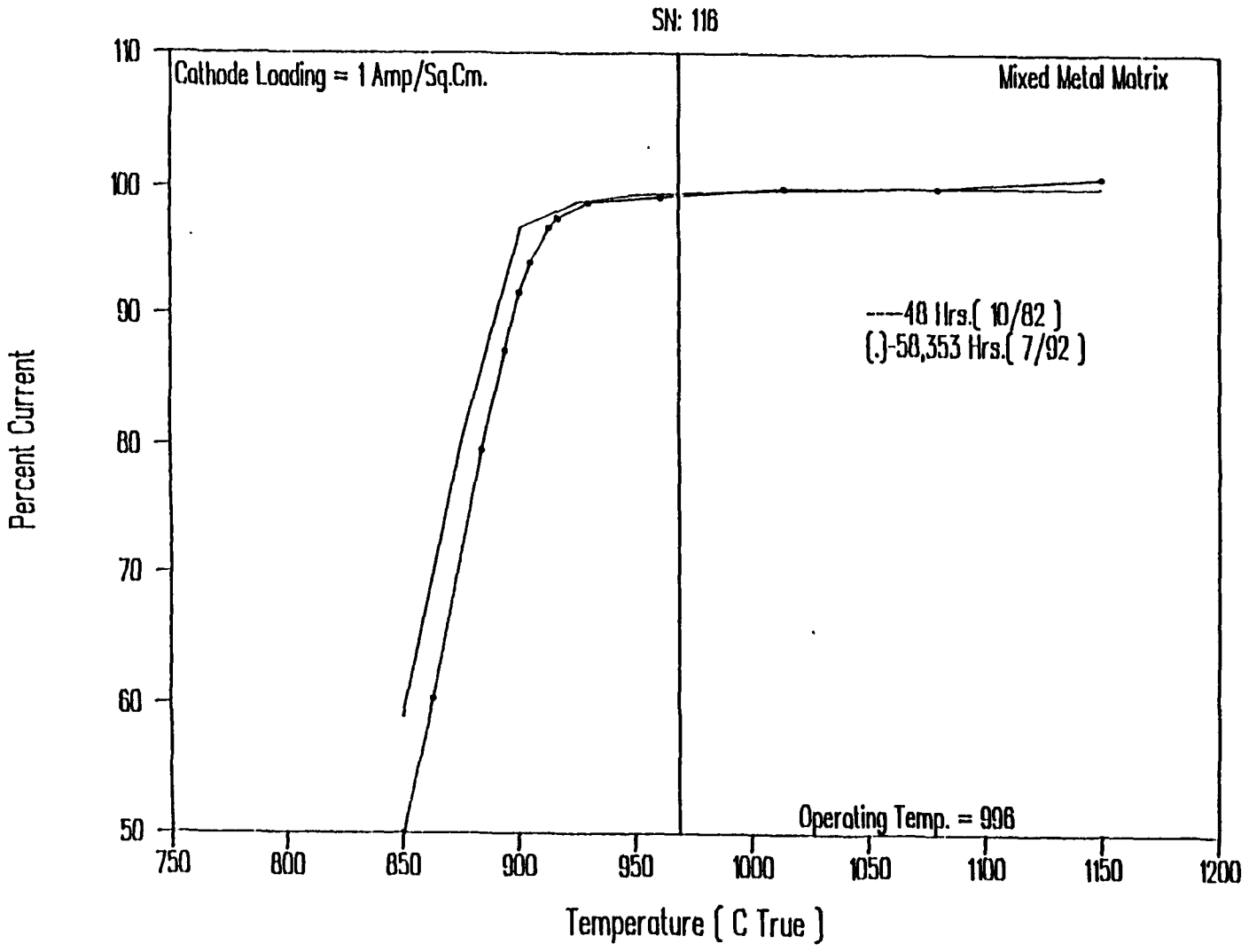

Figure 6-10. MMM-116 Miram Curve

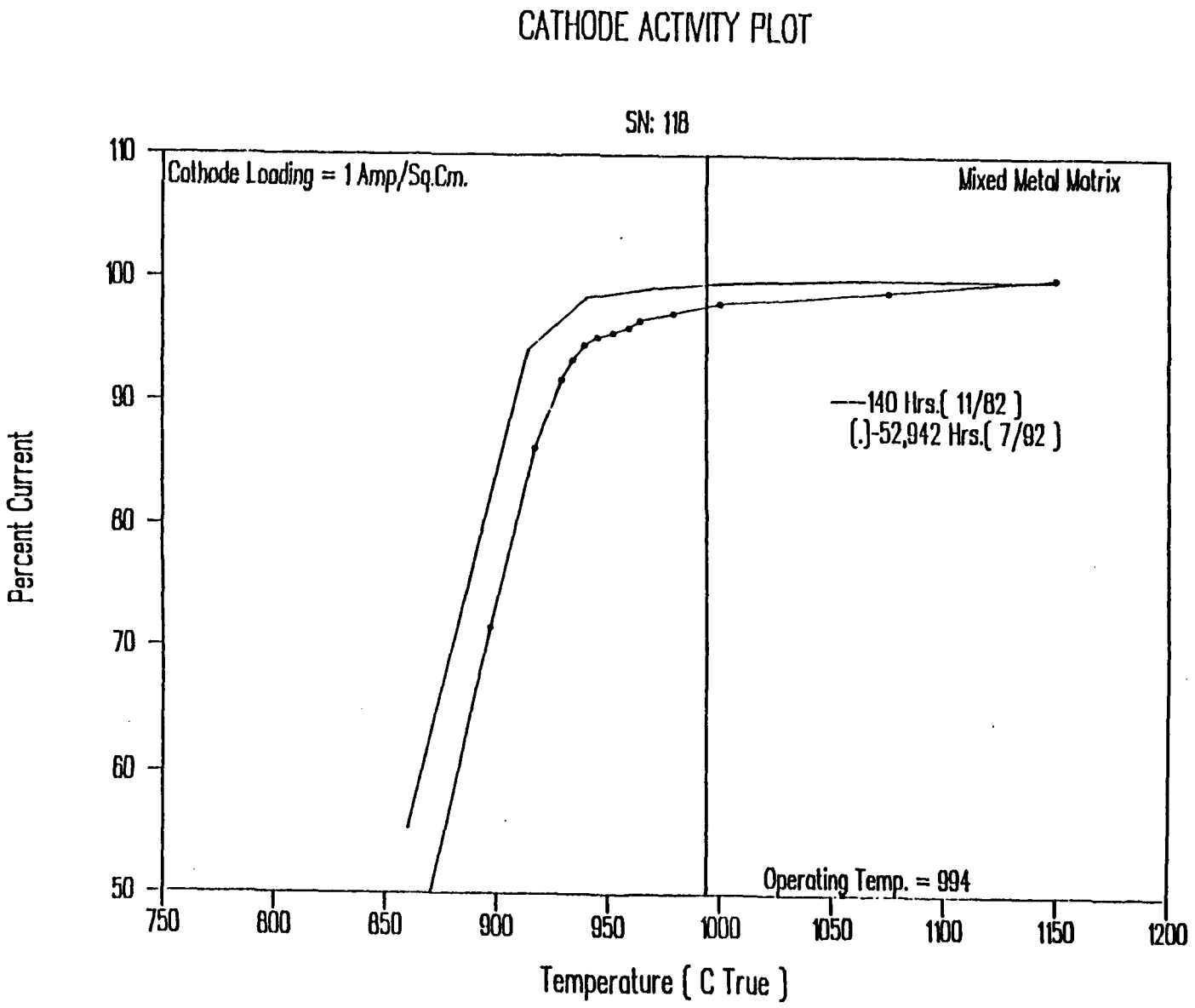

Figure 6-11. MMM-118 Miram Curve

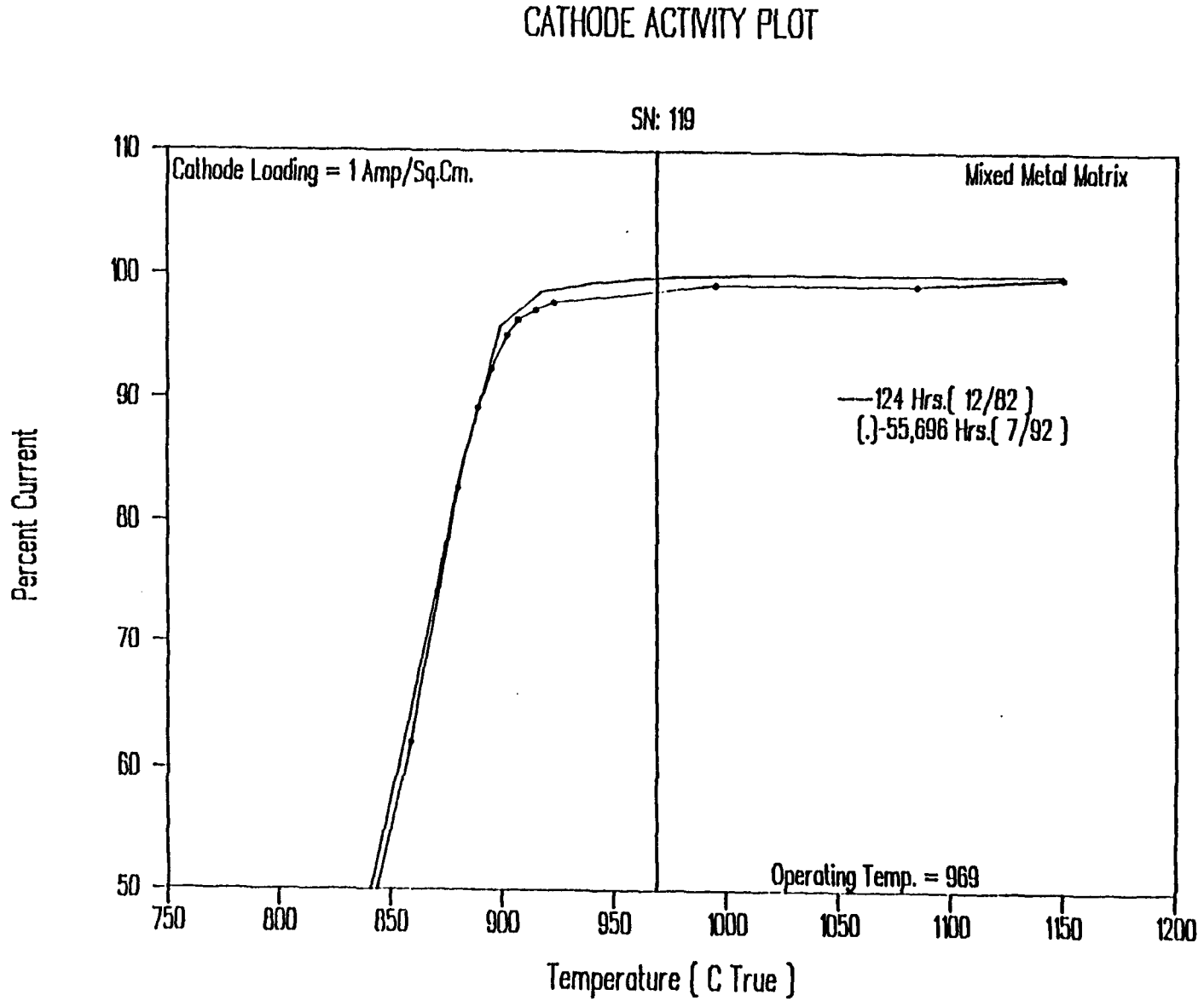

Figure 6-12. MMM-119 Miram Curve

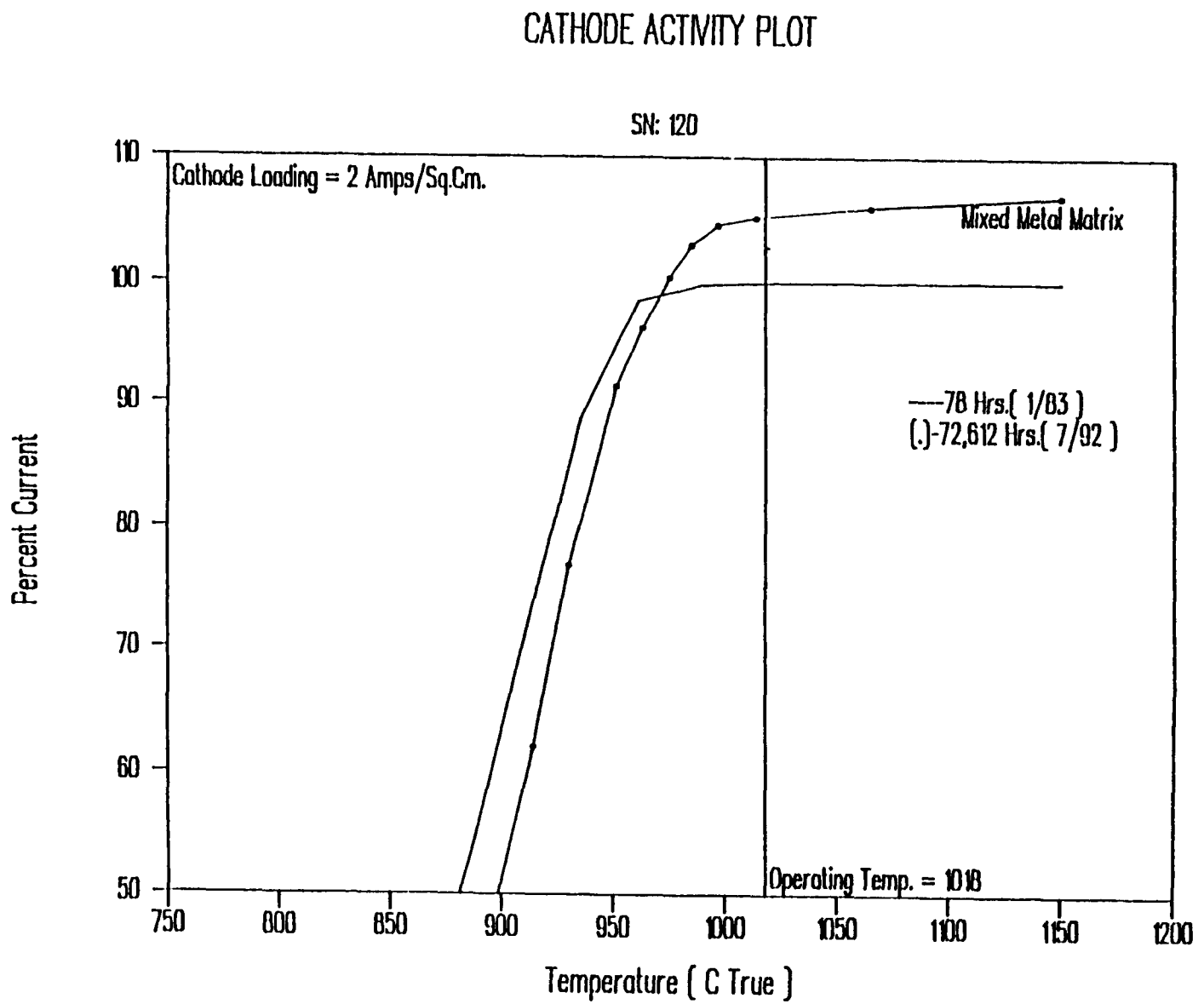

Figure 6-13. MMM-120 Miram Curve

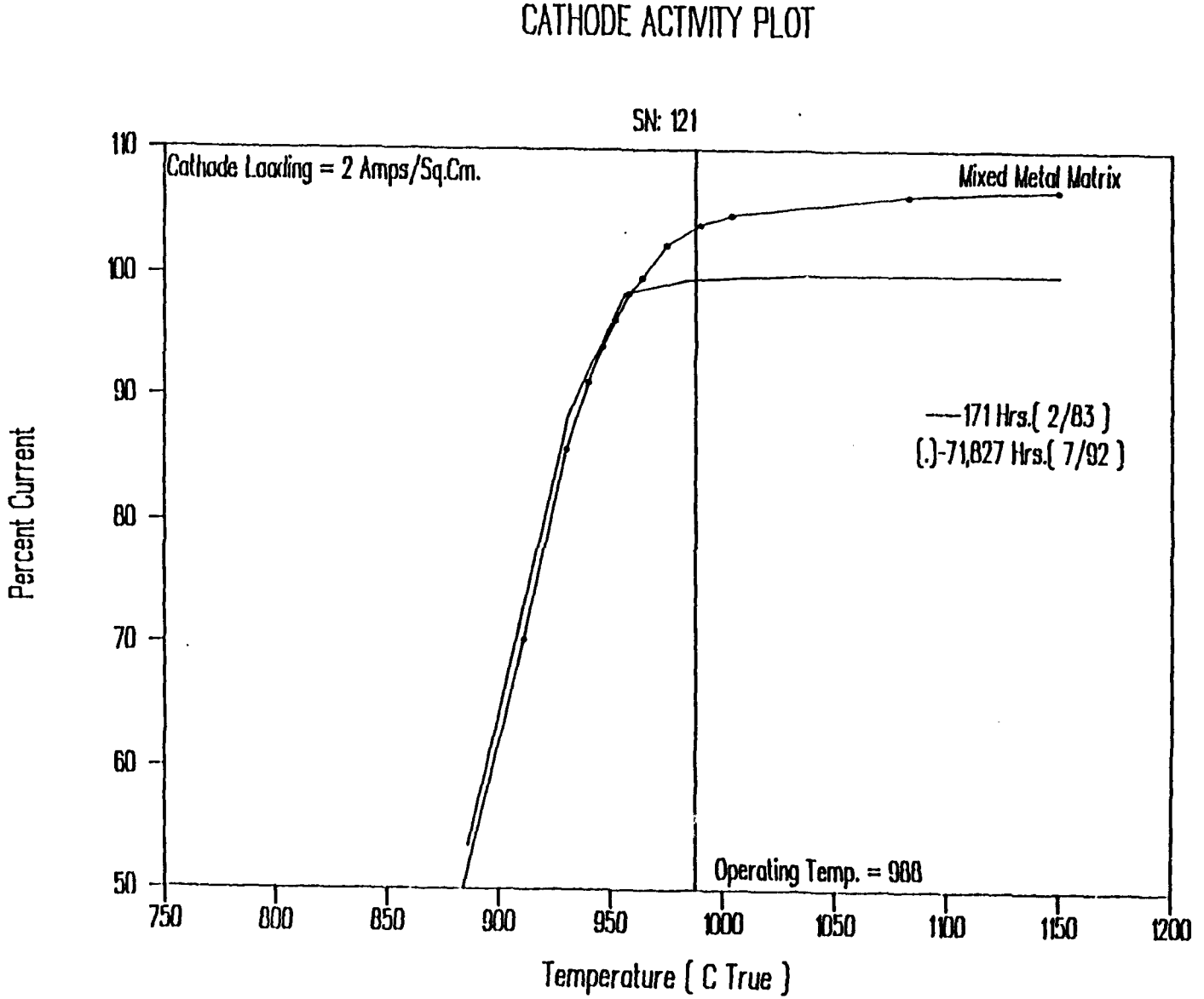

Figure 6-14. MMM-121 Miram Curve

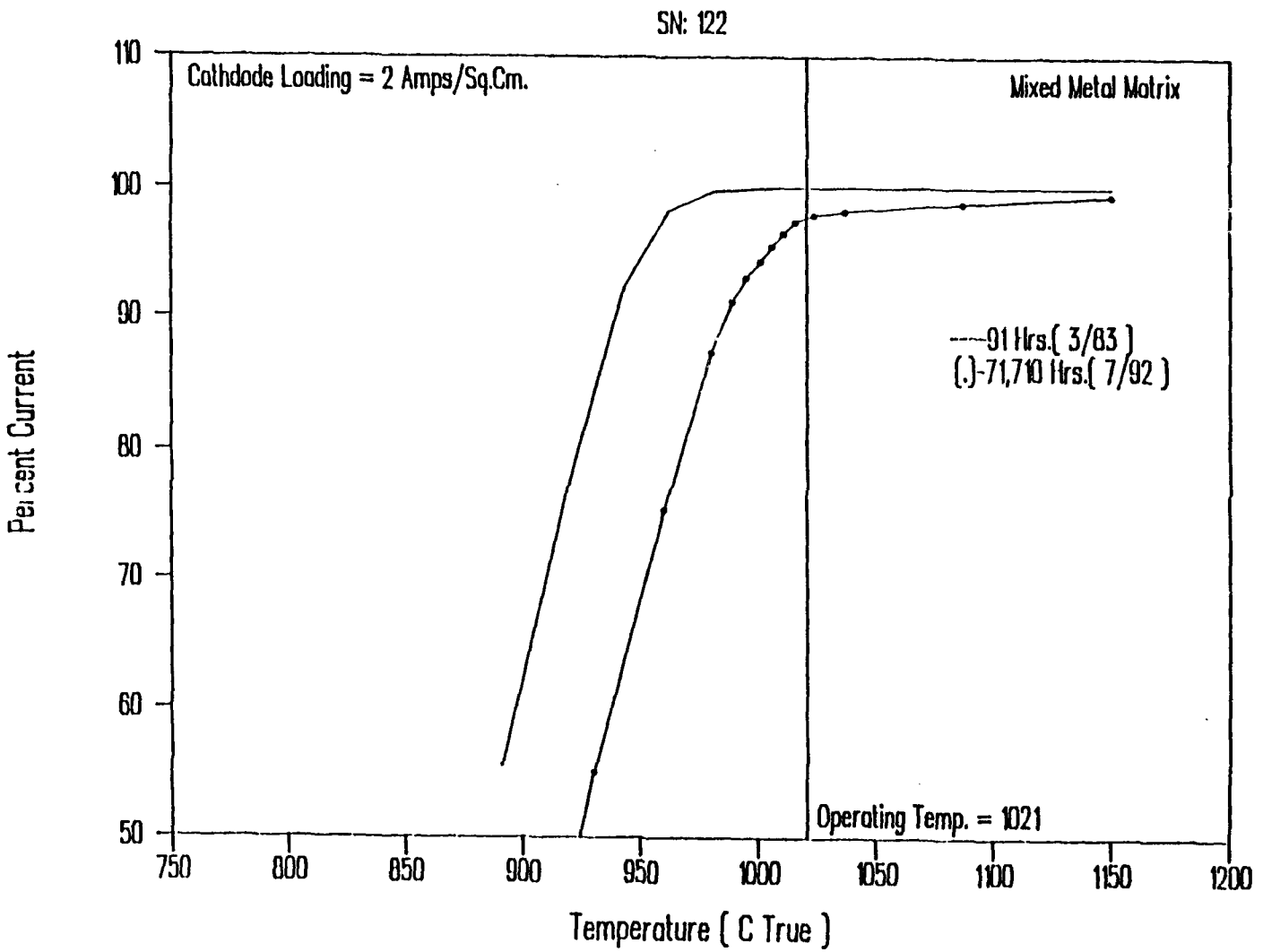

Figure 6-15. MMM-122 Miram Curve

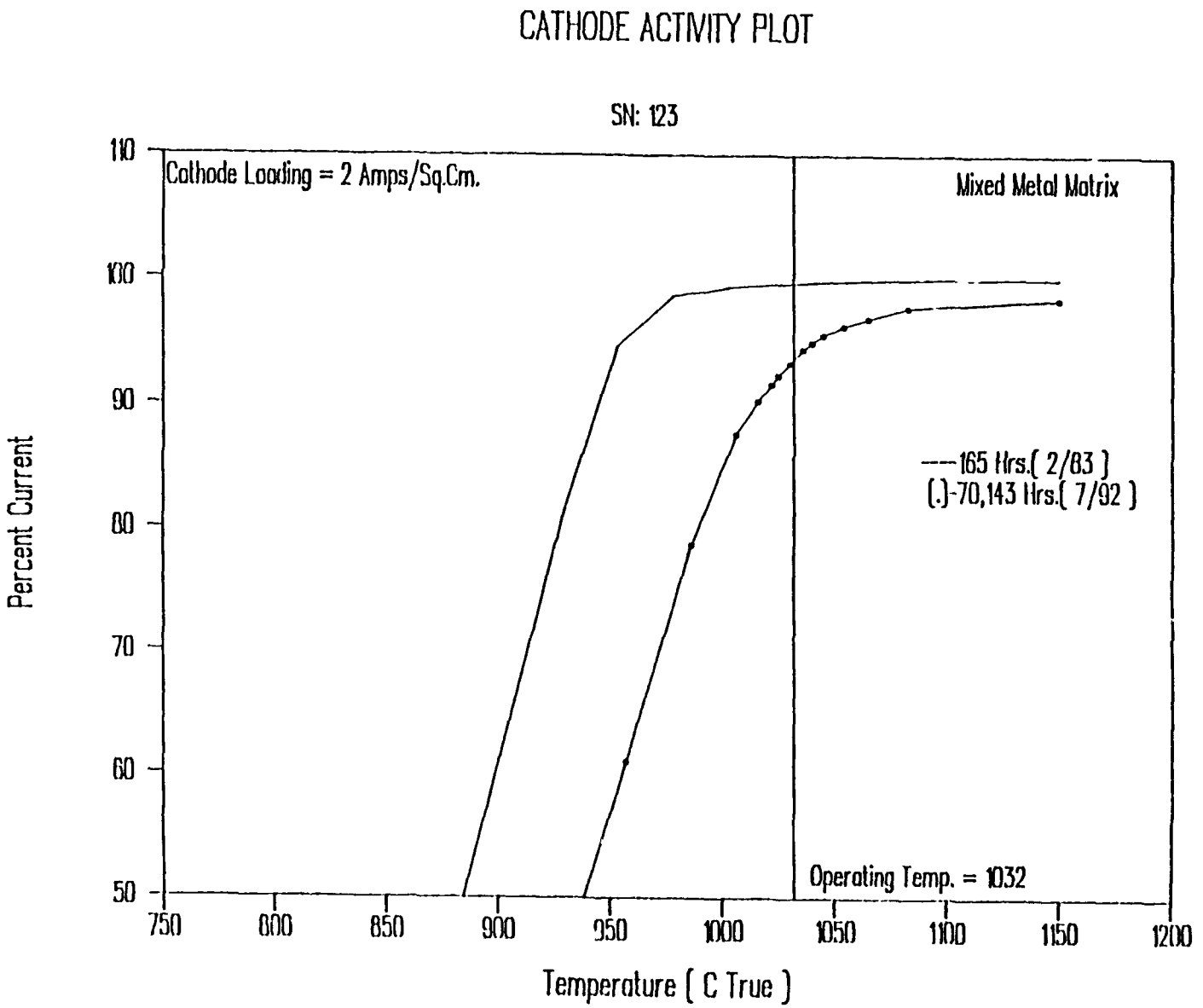

Figure 6-16. MMM-123 Miram Curve

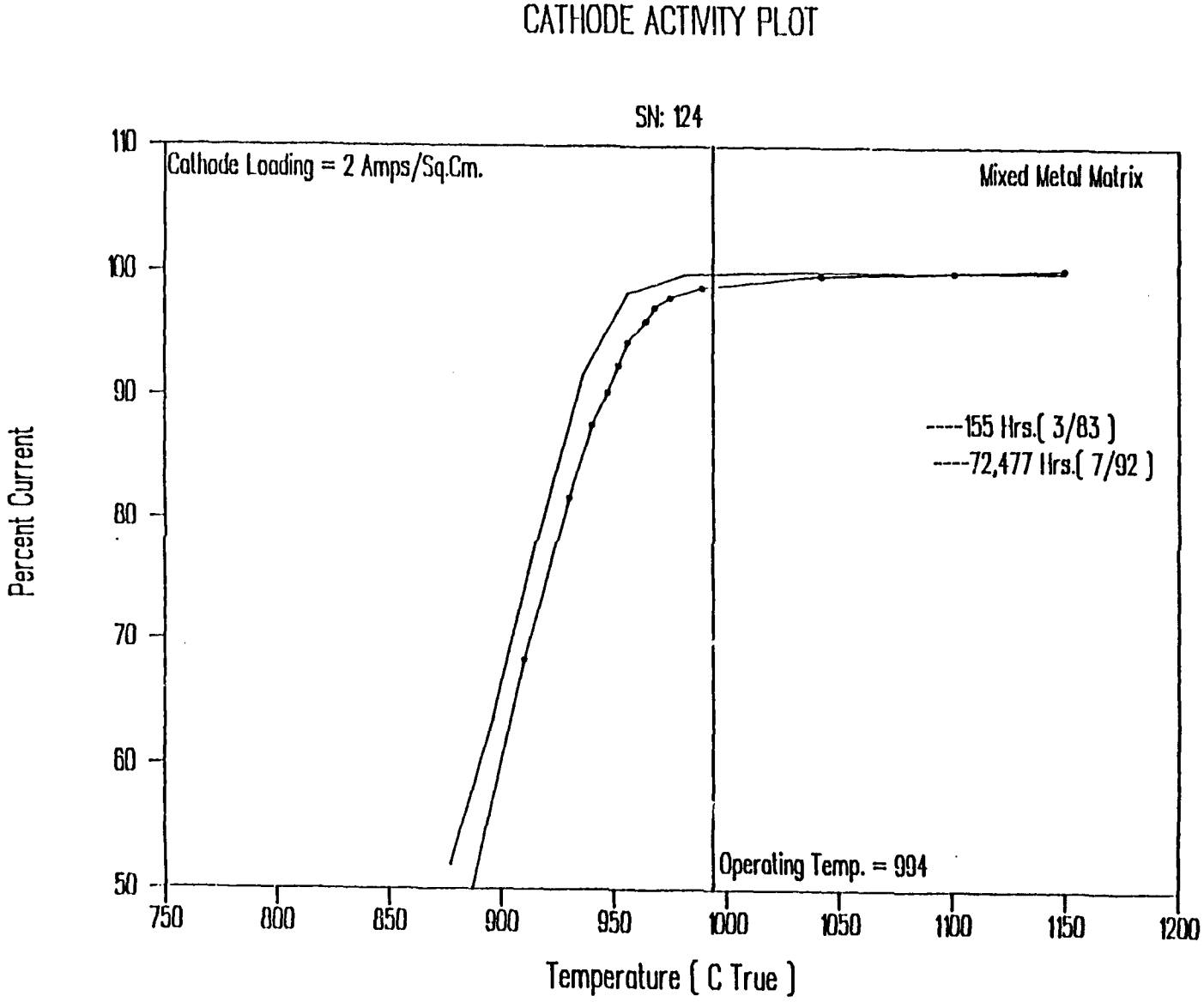

Figure 6-17. MMM-124 Miram Curve

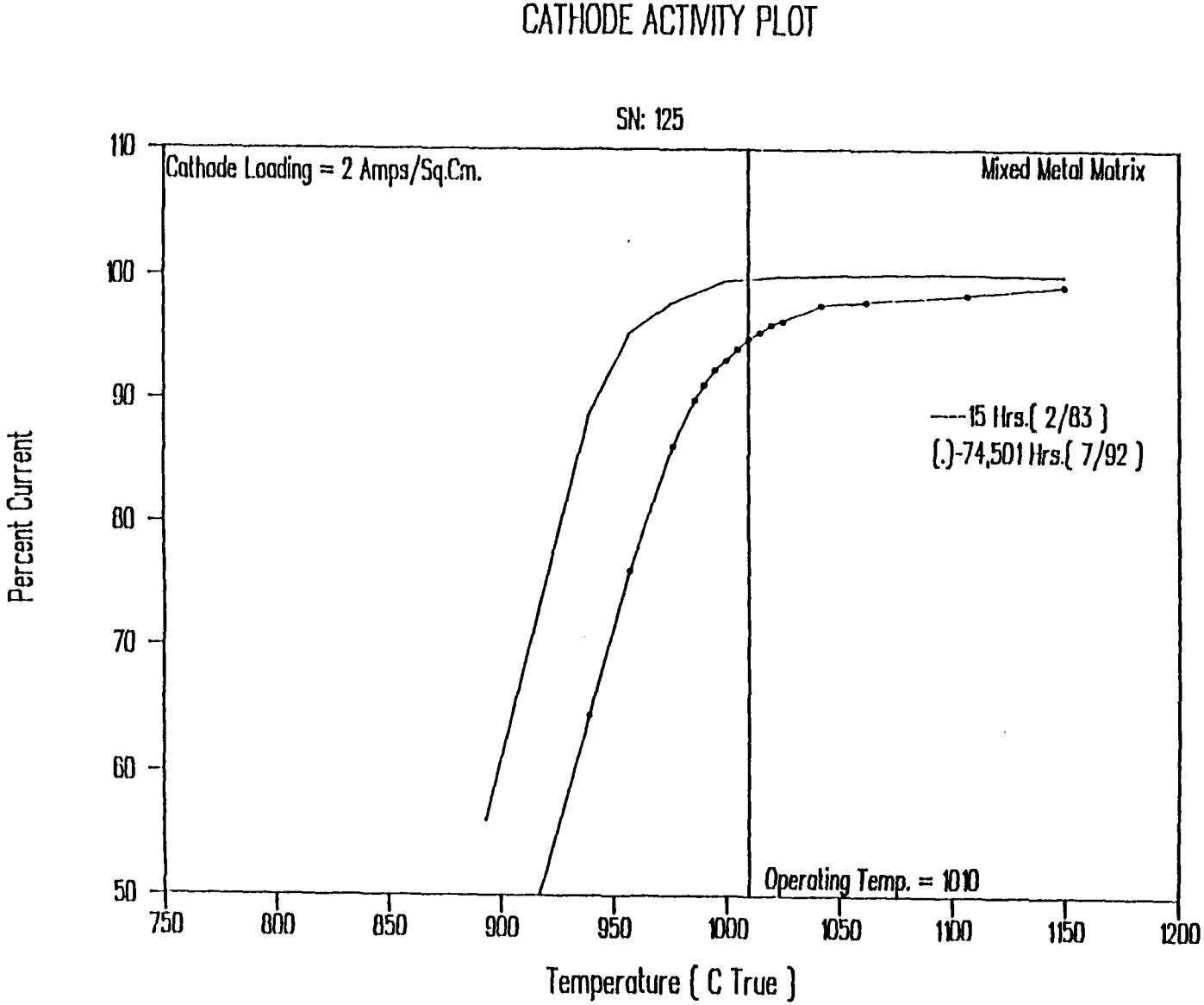

Figure 6-18. MMM-125 Miram Curve

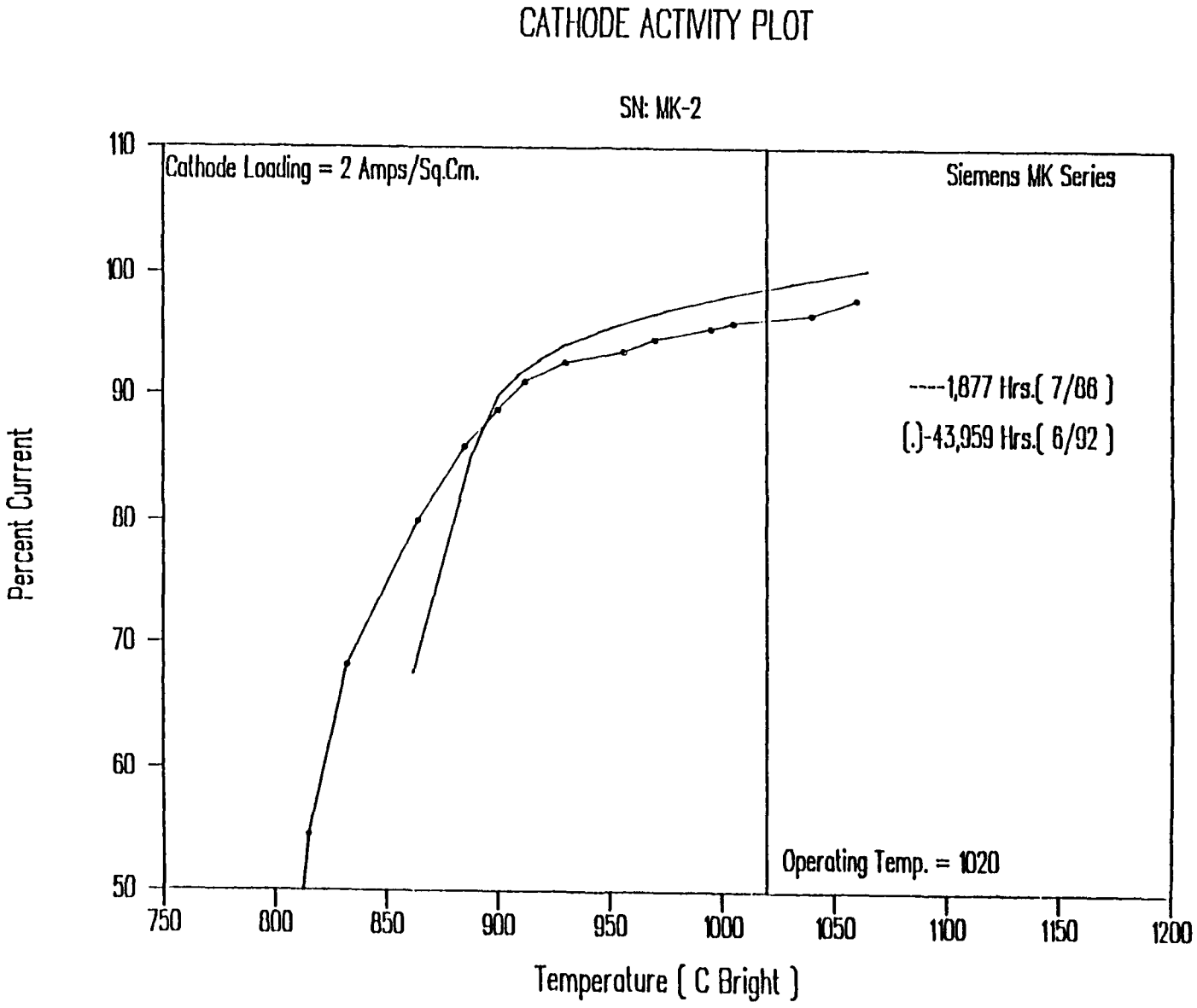

Figure 6-19. MK-2 Miram Curve

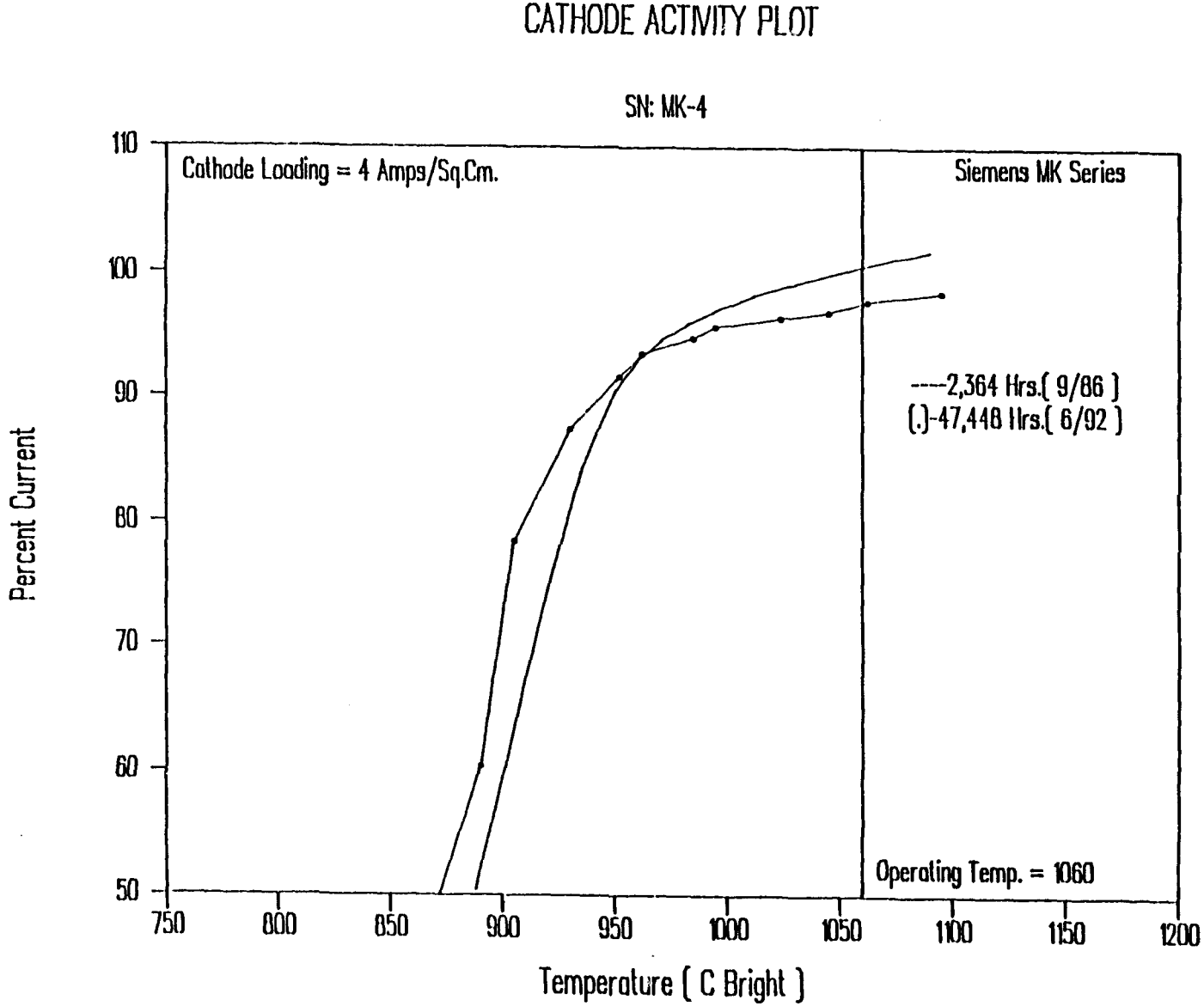

Figure 6-20. MK-4 Miram Curve

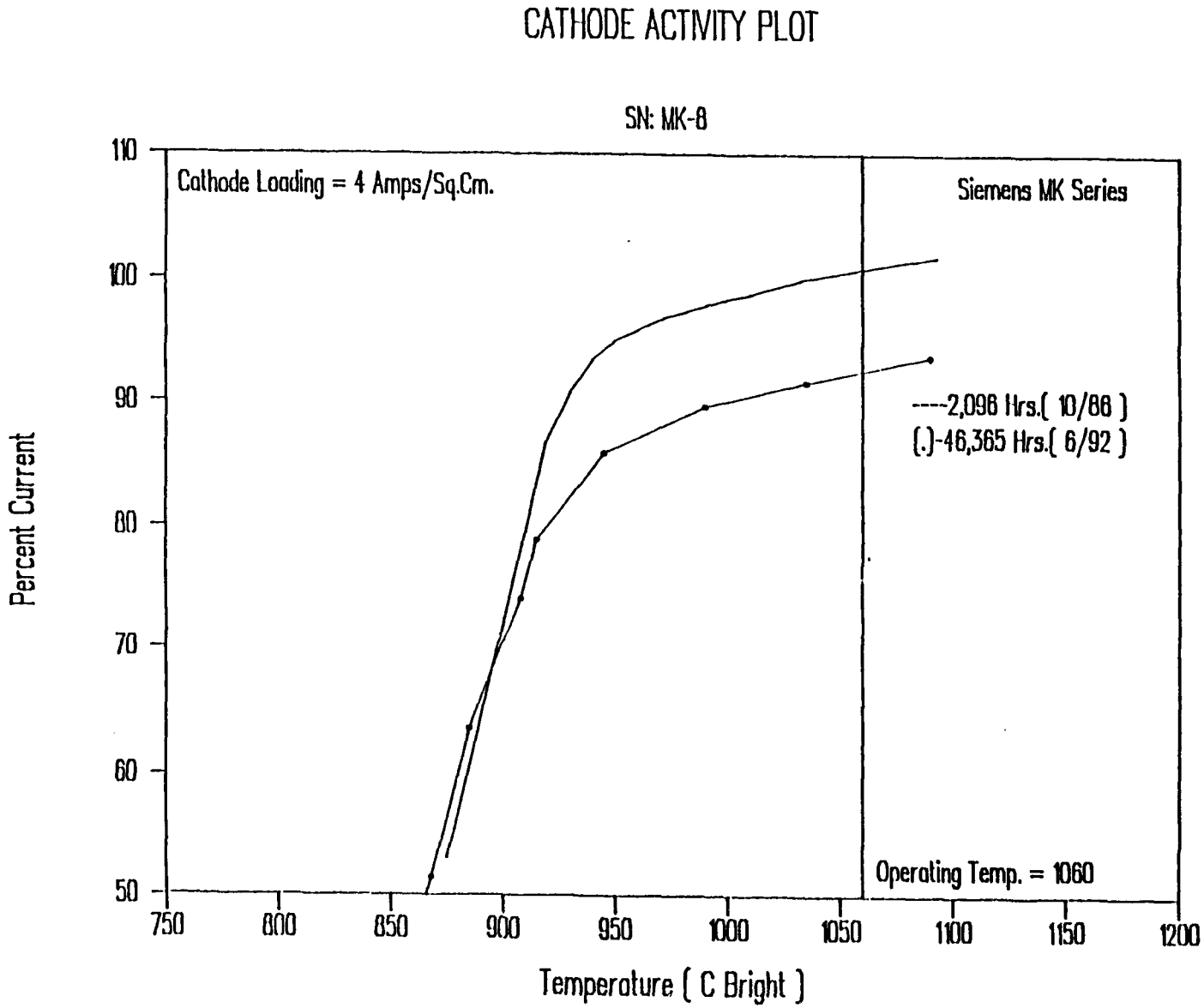

Figure 6-21. MK-8 Miram Curve

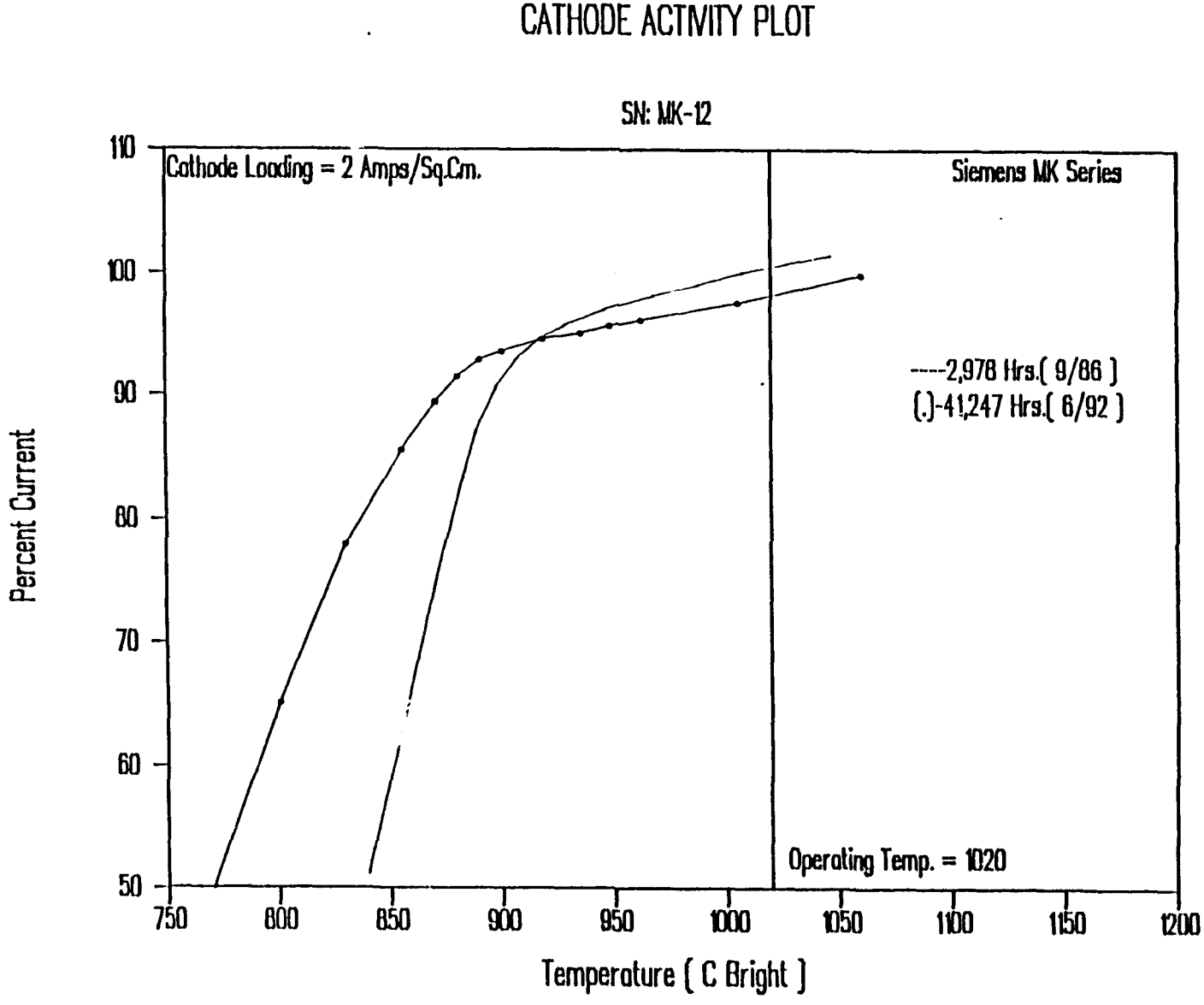

Figure 6-22. MK-12 Miram Curve

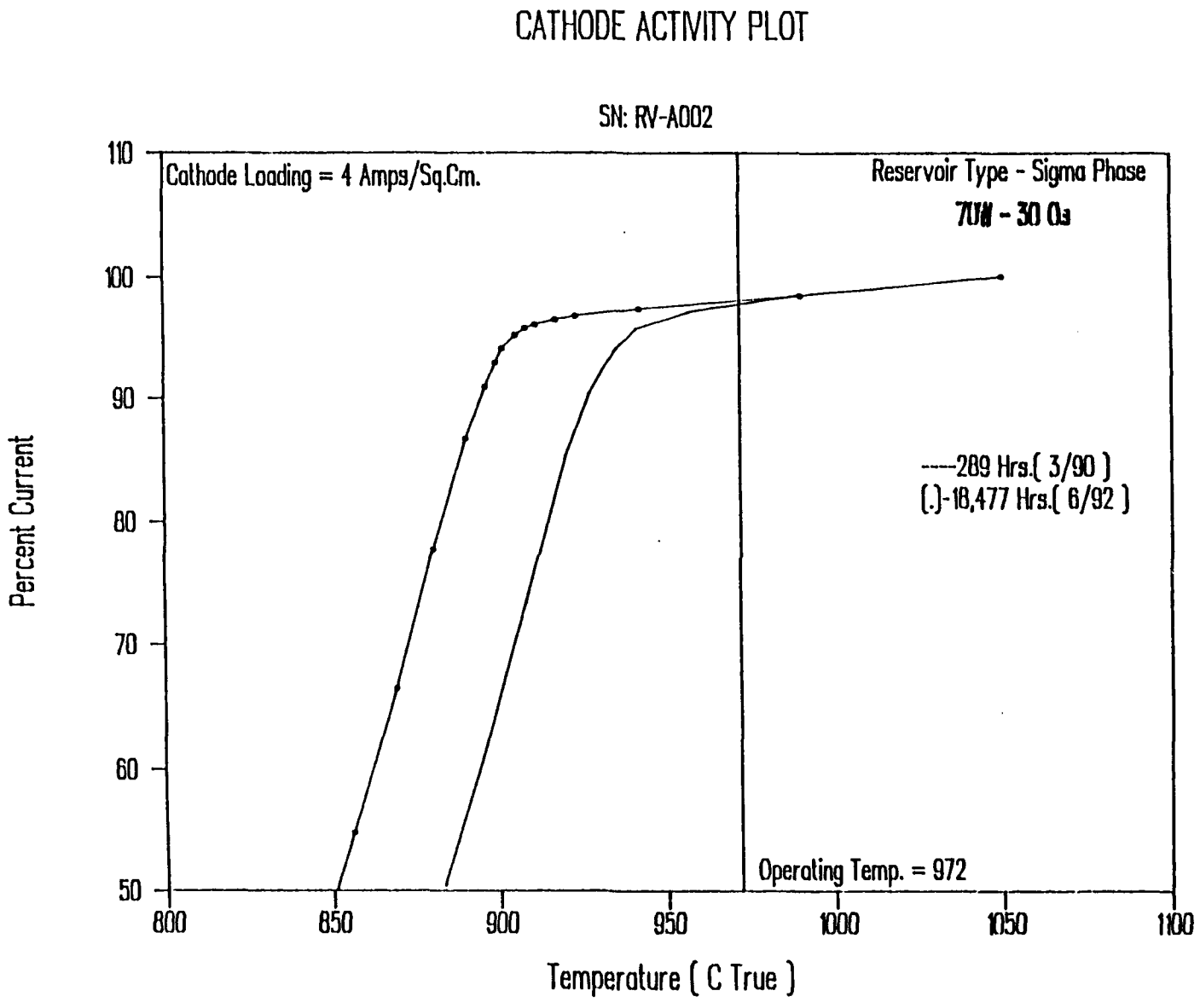

Figure 6-23. RV-A002 Miram Curve

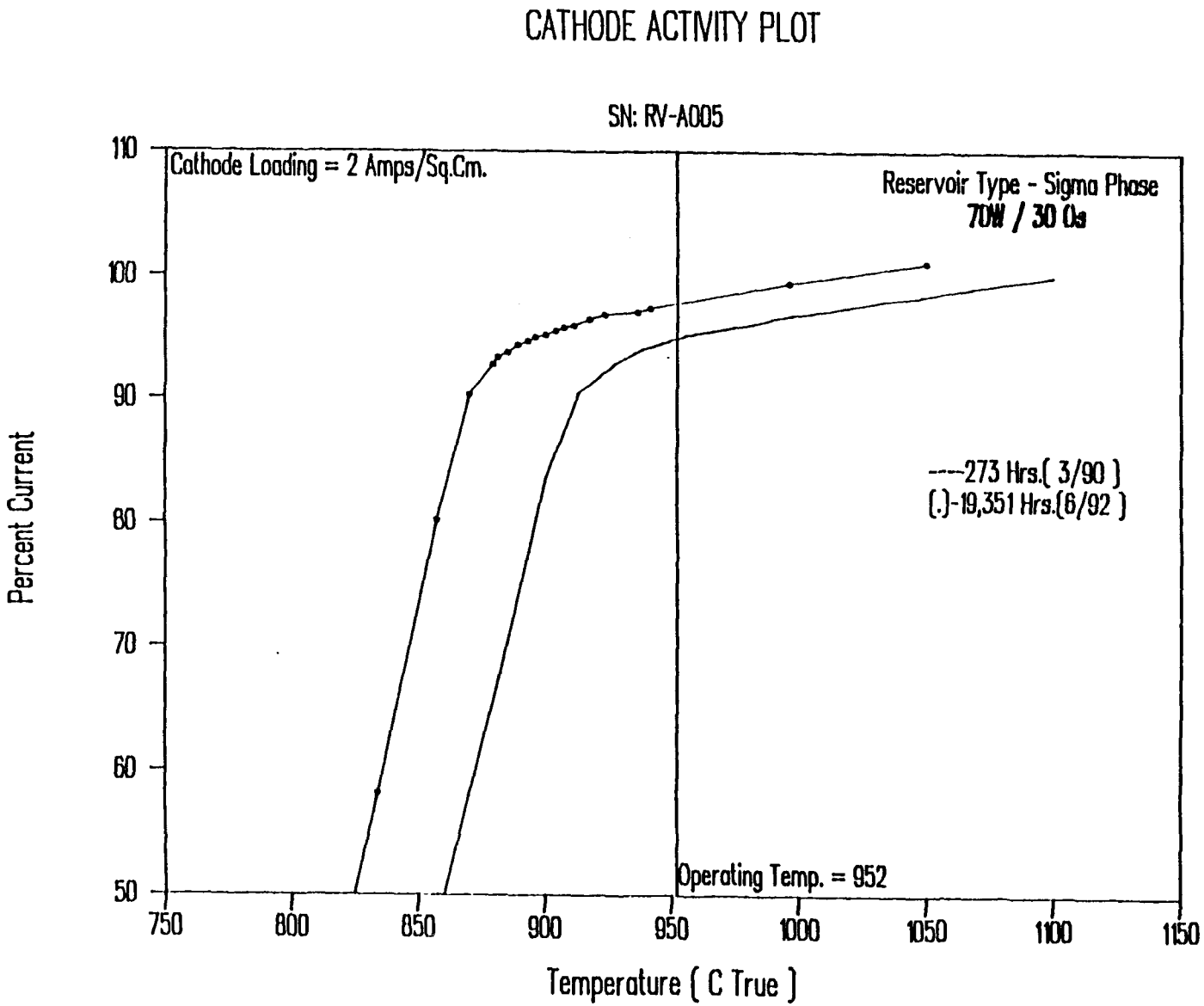

Figure 6-24. RV-A005 Miram Curve

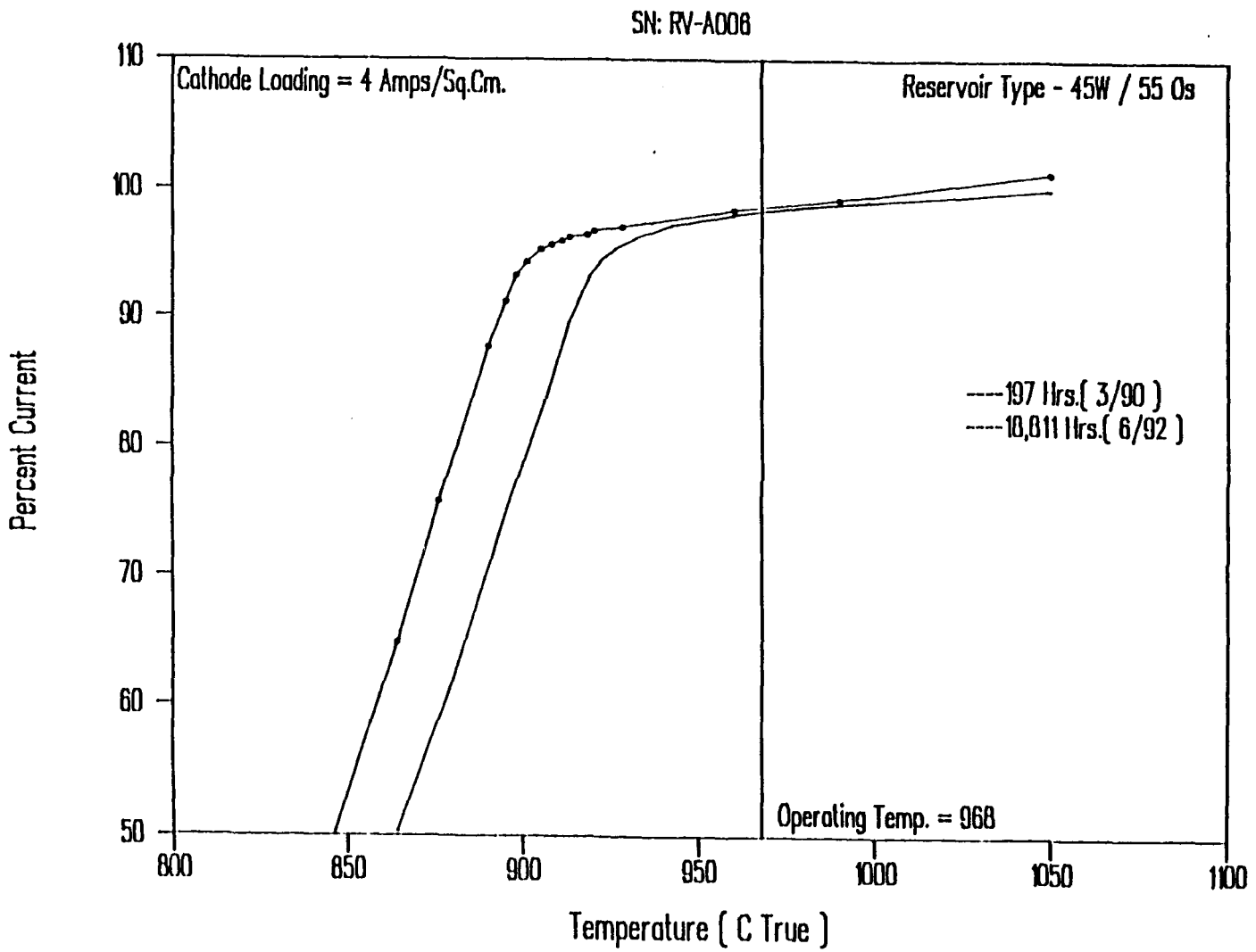

Figure 6-25. RV-A006 Miram Curve

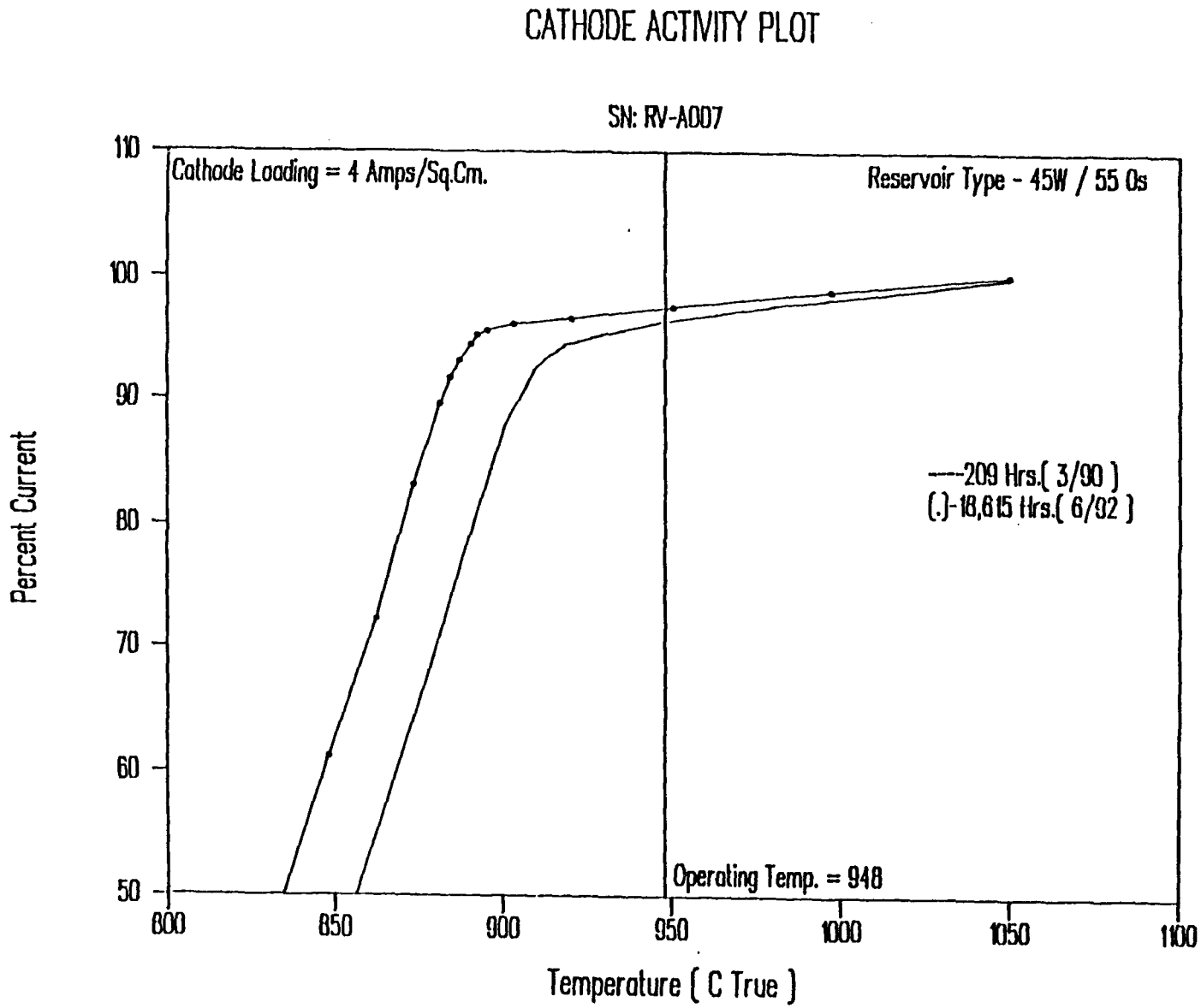

Figure 6-26. RV-A007 Miram Curve

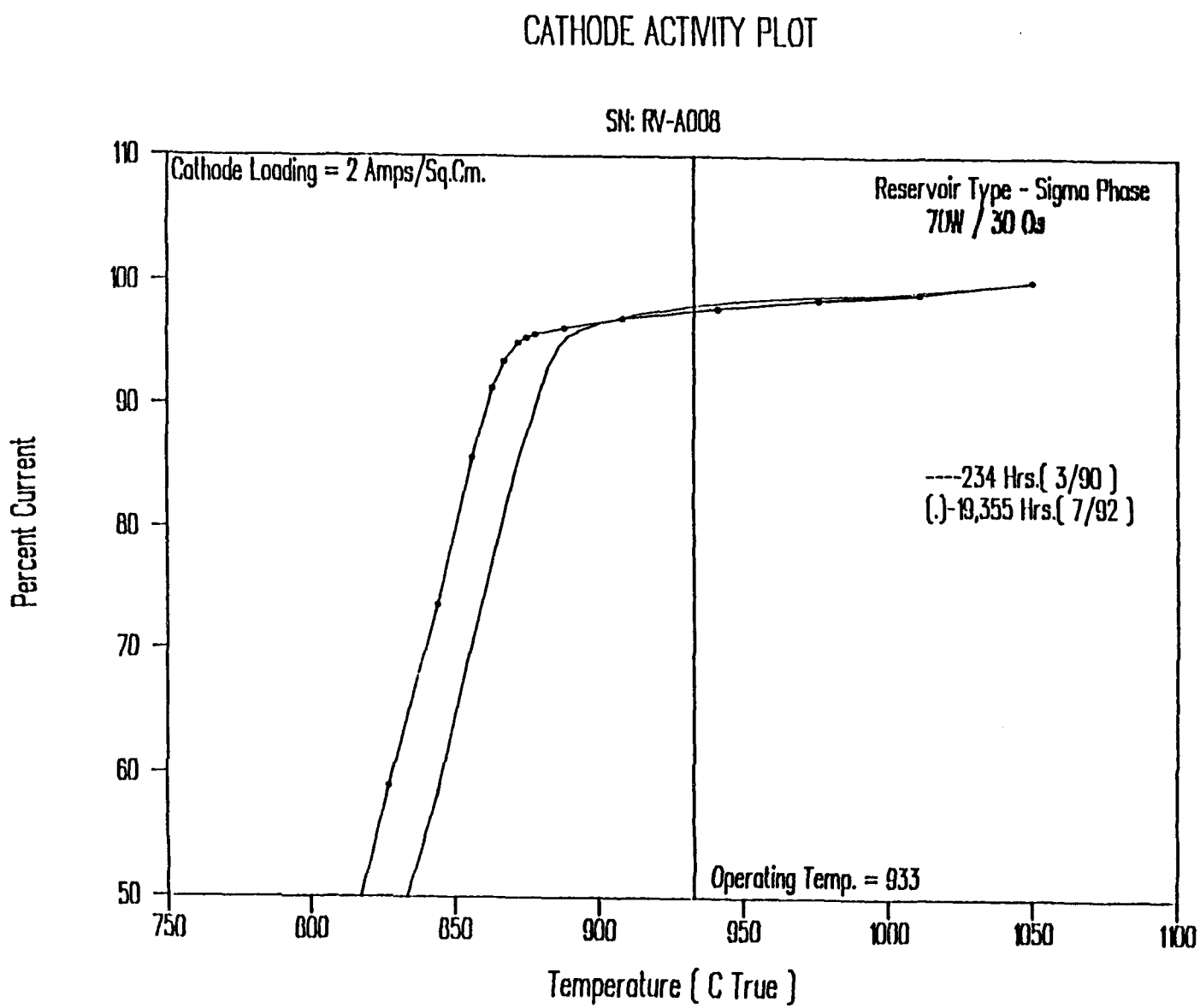

Figure 6-27. RV-A008 Miram Curve

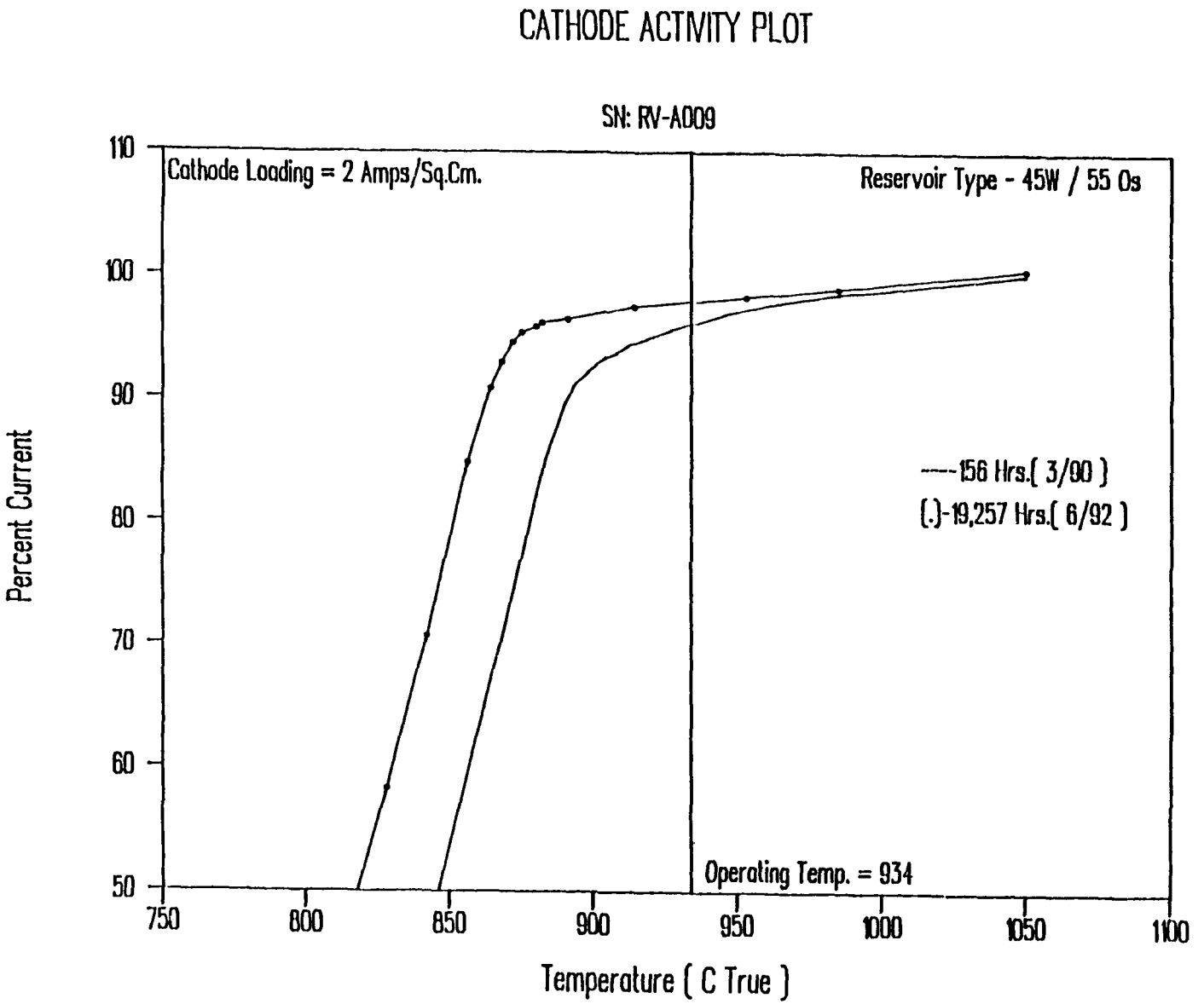

Figure 6-28. RV-A009 Miram Curve

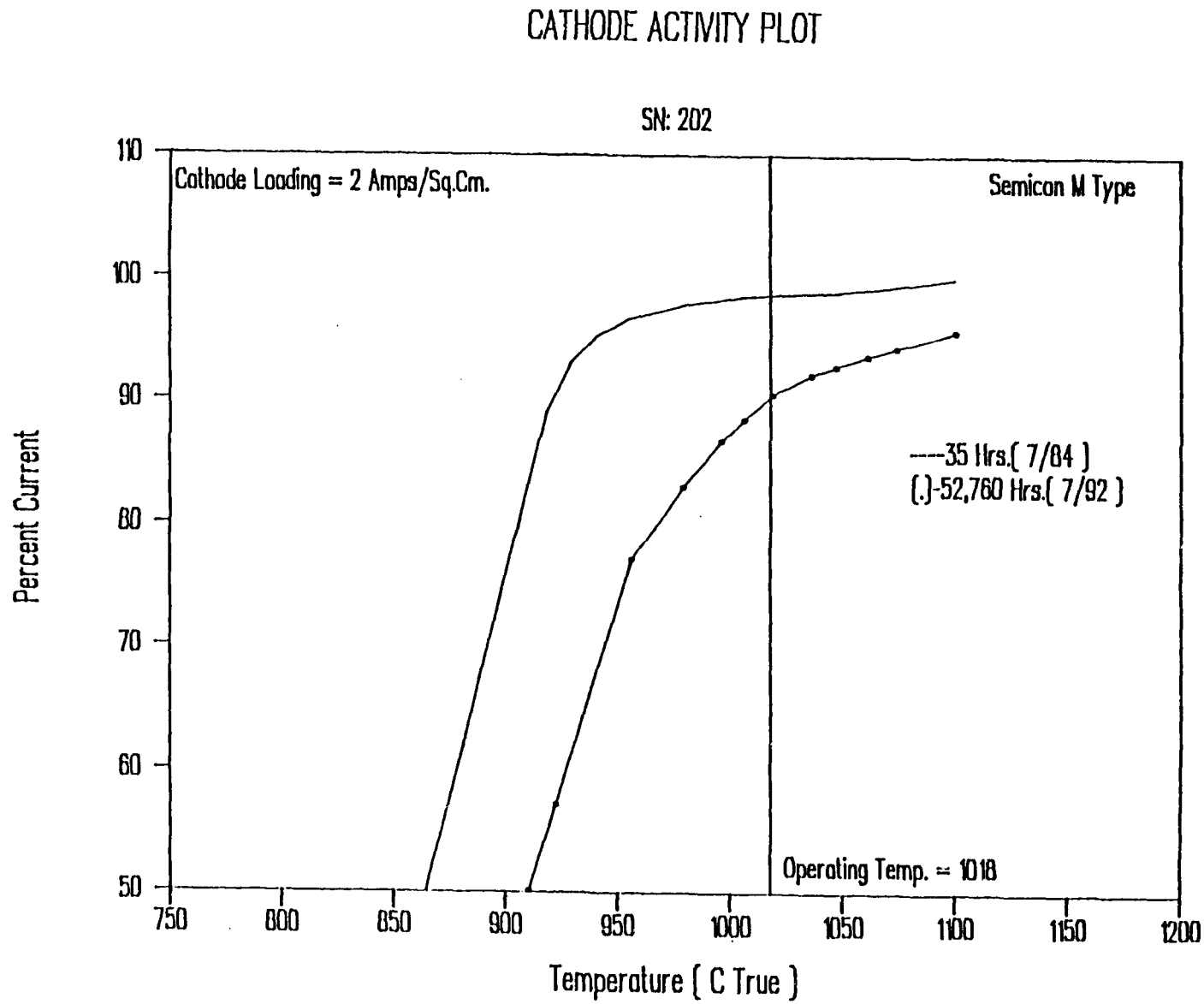

Figure 6-29. M-202 Miram Curve

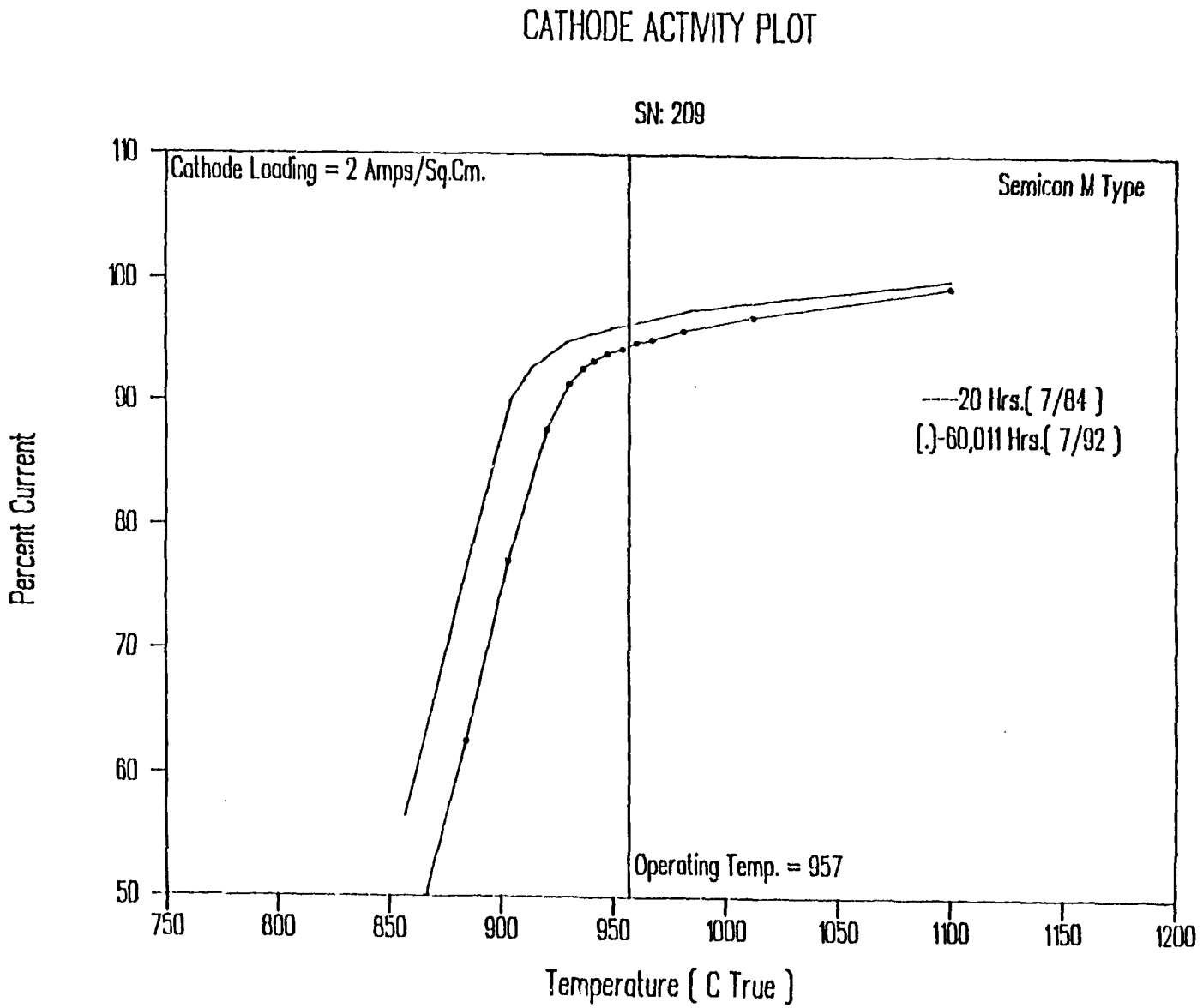

Figure 6-30. M-209 Miram Curve

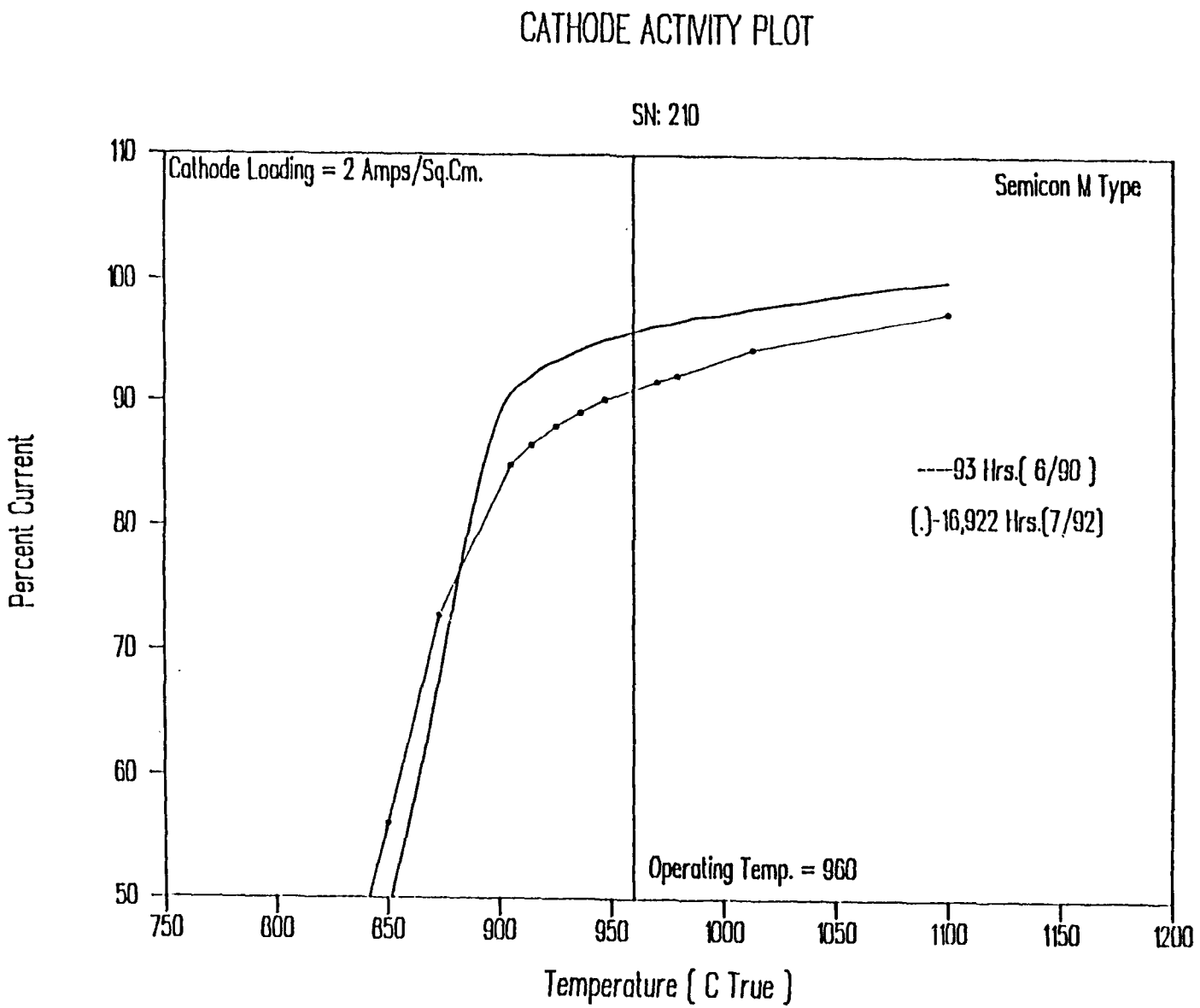

Figure 6-31. M-210 Miram Curve

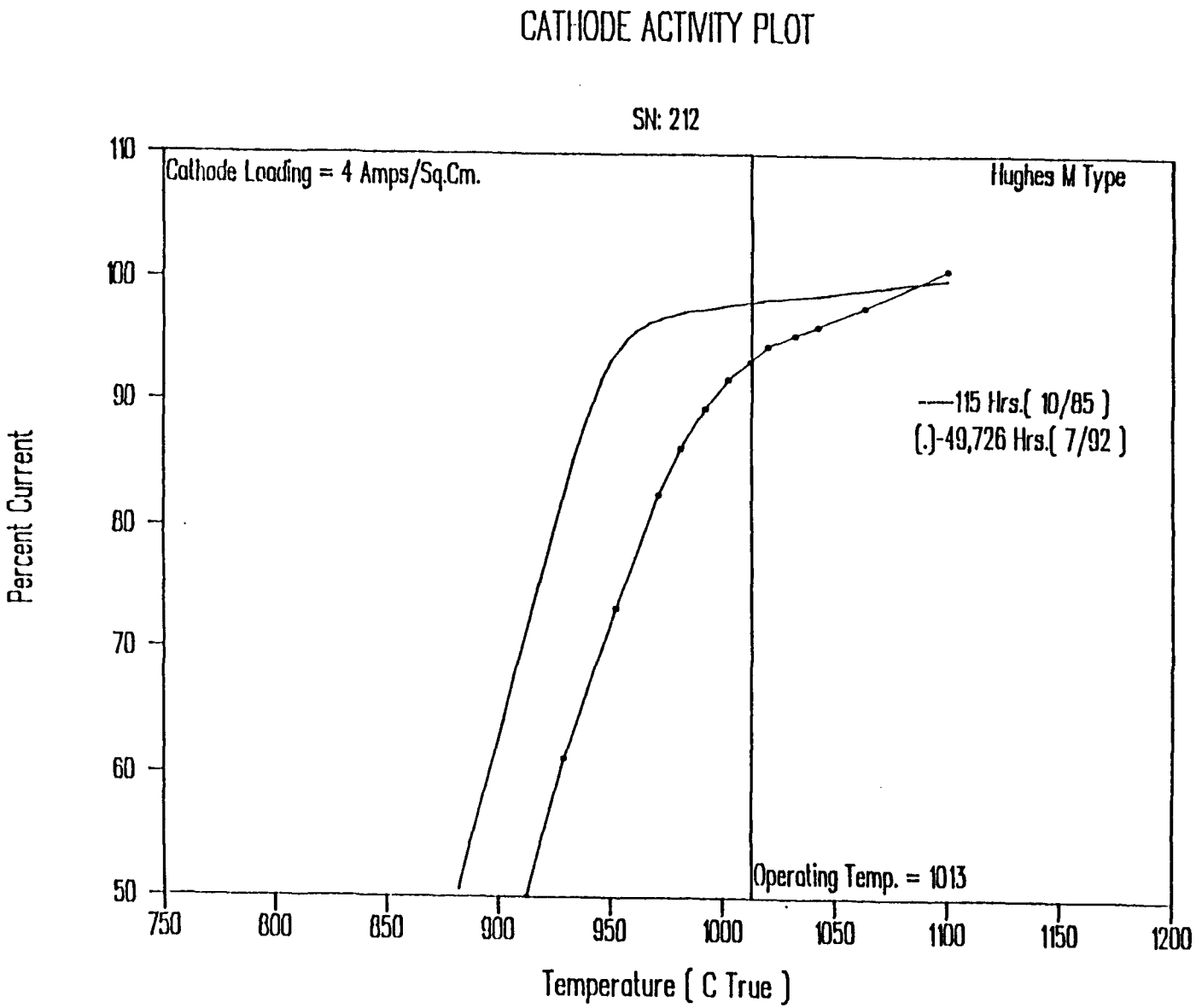

Figure 6-32. M-212 Miram Curve

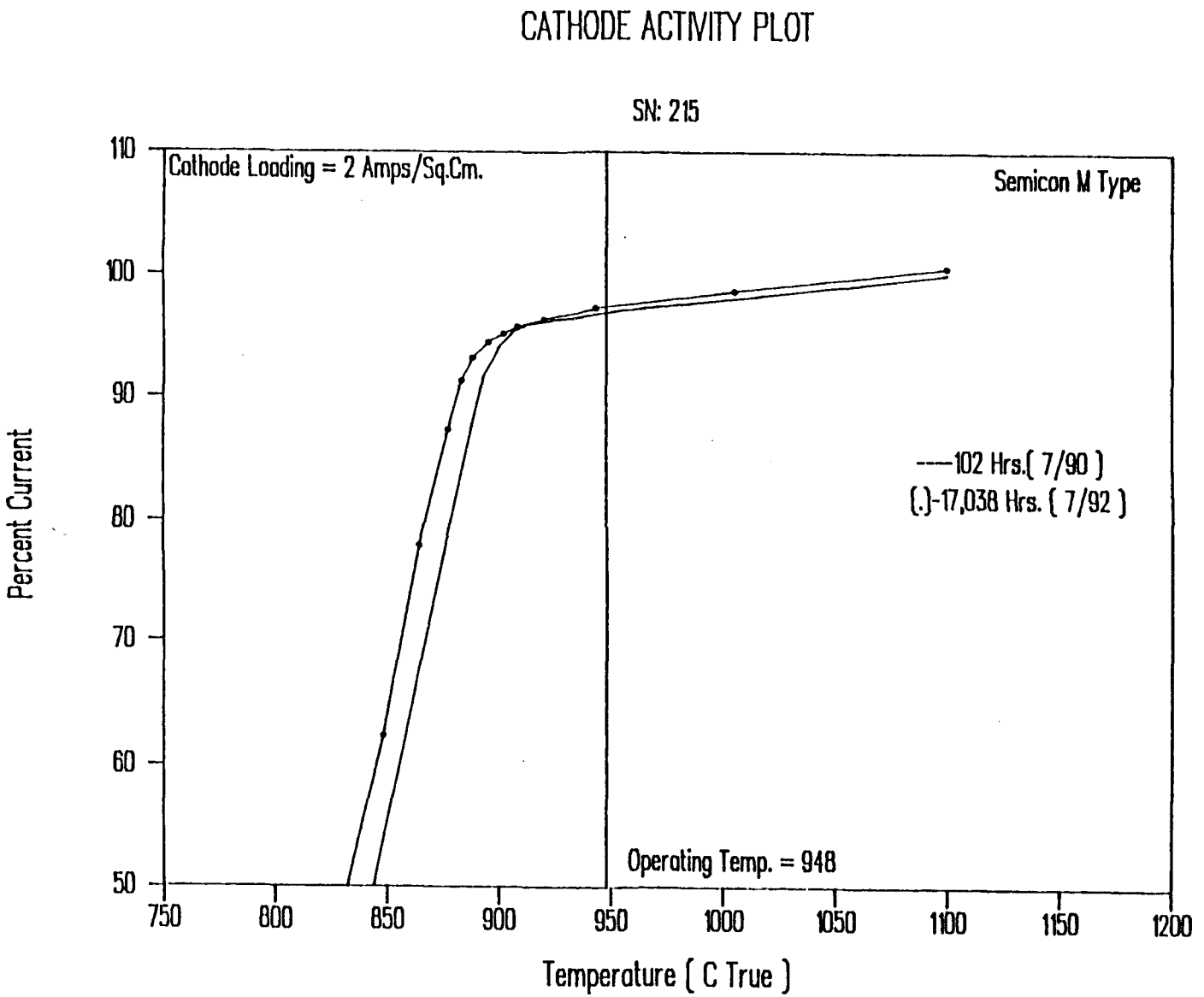

Figure 6-33. M-215 Miram Curve

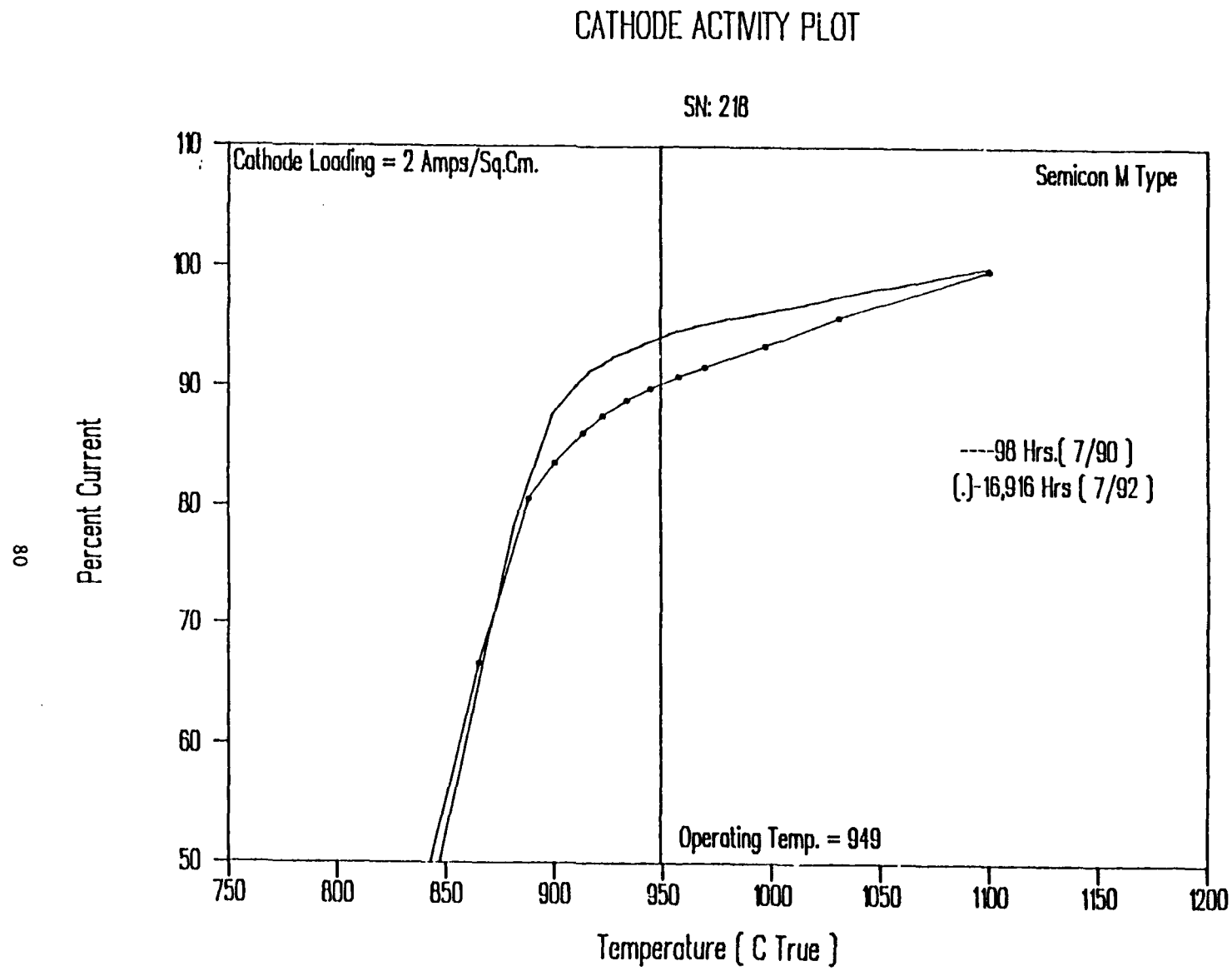

Figure 6-34. M-218 Miram Curve

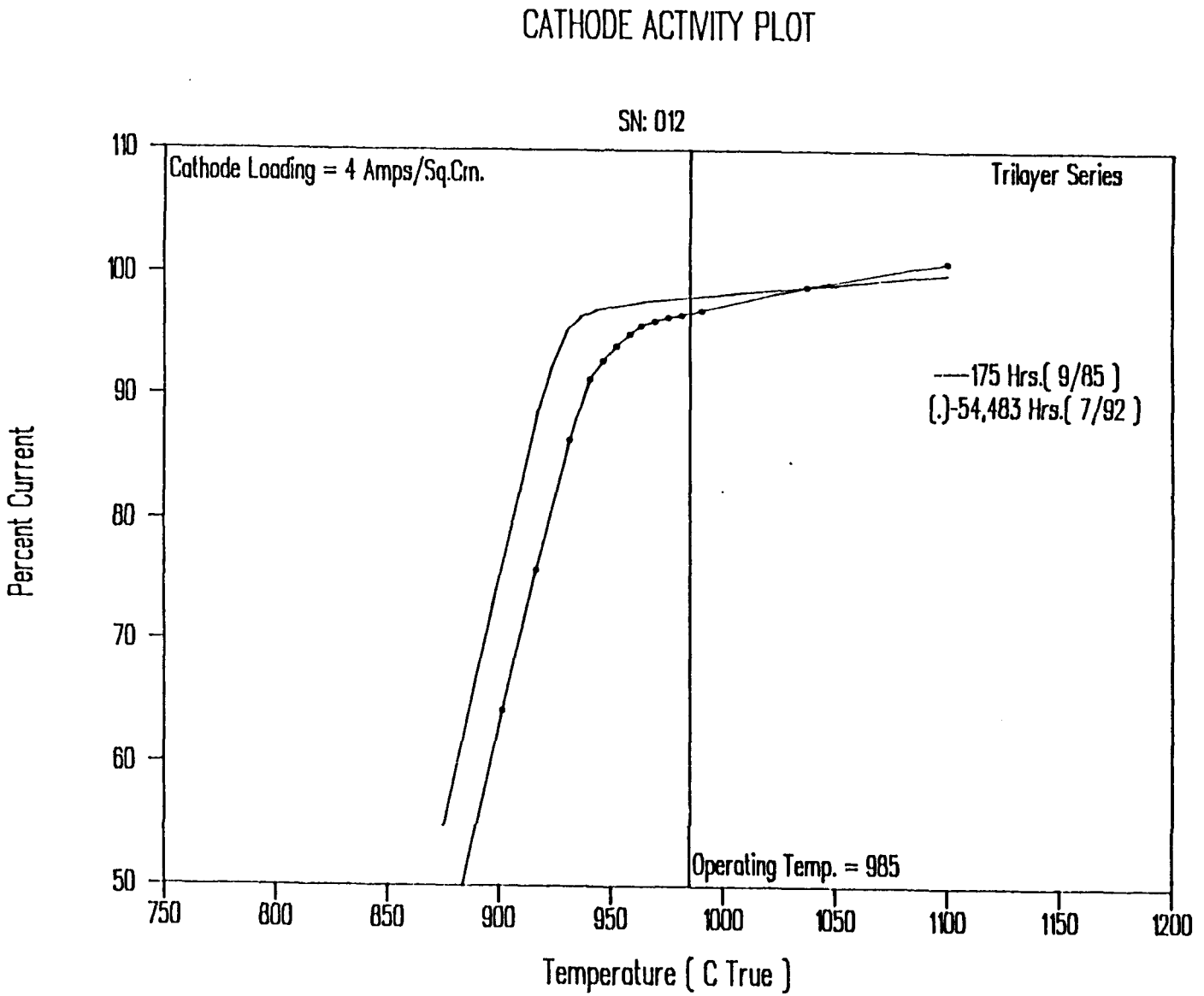

Figure 6-35. TL-012 Miram Curve

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2) R. Jardieu, R. Macior, "Cathode Life Prediction", December 1991

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